Library
CONSERVATION

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Late Dinesh Chandra Sarkar
First Librarian
State Central Library, West Bengal.

Our beloved teacher and guide,
who have inspired us.

Kalyan
Partha

FOREWORD

It is not until the end of the World War II, public awareness was focussed on the conservation of library materials. Perhaps the urge for the protection and preservation of library materials during this period was motivated mainly by wartime and cold war fears of military attack and the threat of nuclear devastation. Since then, great strides have been made in the western countries in the field of preservation and restoration of books and allied objects. The library profession has been slowly but steadily responding to the preservation needs. Extensive studies have been conducted to explore the causes of the decay of the printed materials and means to prevent it. In Europe and other parts of the world, restoration centres, mostly with government support, have been making organised and coordinated efforts to further conservation of library materials. Researches at private and public laboratories, regional and state planning, and the developments of local programs to attack various aspects of the conservation problems also have marked the increasing professional awareness in this area. Aided by UNESCO, two professional societies, the International Institute for Conservation of Historic and Artistic Works (IIC) and the American Institute for Conservation of Historic and Artistic Works (AIC), were established. Both of them have been active in raising standards in conservation in a number of ways. In the United States, the National Conservation Advisory Council was set up to survey the nation's needs in conservation and to recommend action to meet them. The International Council of Museums' Conservation Committee has been very much active in the research in all aspects of conservation. The devastating flood of 1966 in Florence, Italy, which caused large scale destruction of libraries and museums, invited strong public attention on the subject of conservation ; and the binders, restorers and conservators all over the world made a massive salvage effort. In the library schools, library conservation has emerged as a distinct discipline closely affiliated with paper technology, sciences of chemistry and physics, and other fields of conservation. There is a great effort among the publishers and paper-making industries to work together ; and more and more books are being printed on permanent/durable paper.

A book is not a permanent object. Like human beings, it does deteriorate. However, a book has a better chance of long and lasting life if it is manufactured on paper of durable quality, paper fitted to the needs the volume serve, the demands it cater. The librarians, as the custodian of cultural property, have the responsibility to preserve it. Unlike the museum, the library materials are not stationary. They are meant to be used, hence, they are exposed to all sorts of mishandling and mistreatment. The excessive heat, humidity, dust and other problems cause books to decay. The deterioration of books has increased over the years to an alarming proportion because of their large scale production and the temptation of the publishers to cut corners and economise on materials. One result to this mass production was the use of paper whose physical and chemical components have proven to be highly unstable. Their susceptibility to deterioration has been aggravated by changes in storage conditions. Frequent temperature and humidity changes brought on by unstable climatic control has accelarated the natural aging process in paper, leather, cloth and glue. Acidity was identified as early as 1829 as a major enemy of paper permanence, but it has only been in recent decades that the full extent of the problem of acid-caused deterioration of paper has been realised. It is clear that mass deacidification is the only hope now to save a substantial number of printed materials approaching brittleness in the libraries and archives.

In a recently conducted survey of large academic and research libraries in the United States, it has been revealed that nine out of ten books in the Northwestern University Libraries need treatment and that 30.4% of the collection of the Smithsonian Institution Library is brittle and require immediate attention. For preservation of library materials, advanced type of copiers and optical disc technology are being explored in the United States. Acid-free paper is becoming more common in the libraries over there and about 40% of the books purchased by the academic and research libraries are on acid-free paper. Harvard University Libraries has adopted a new policy recently of not letting any materials under its control be printed except according to stringent conditions, including acid-free paper.

In India, the conservation of library materials is still a very neglected area. The need for the proper conservation of library materials is much more accute in our country because of the climatic conditions, lack of fire-proof safes and vaults, and air conditioning as well as lack of awareness on the part of the library users in proper handling of the materials. Yet, the library profession is not taking the advantage of the modern technology and know-how currently available for the conservation of library materials. Barring a few exceptions, no serious efforts are being made to train library staff on this important aspect of librarianship or to make the public aware of the importance of preservation and protection of library materials. We also lack good books on preservation, books that will explain the problems. educate us to tackel and provide us with the conservation techniques. The massiveness of preservation problems and the overwhelming cost of their solution strongly advocate the need for government initiative and subsidies. Unless the necessary infrastructure and organisation for a strong campaign for conservation could be provided at a national level very little would be achieved.

In this context, the efforts of the two practicing librarians, Shri Kalyan Kumar Mukhopadhyay and Shri Partha Subir Guha, are to be commended for bringing out this timely publication. Their monograph, previously published in Bengali and well received by the profession, gives a detailed background information on the history of the book and paper, deals with the environmental conditions, physical condition of the collections, organisation of preservation functions, disaster control, preservation resources and planning. The authors discuss the problems inherent in proper care and handling of library materials as well as actual description of what could be done to prevent further deterioration of such materials. They recognise the problems and the importance of bringing the readers thoroughly 'up to date' with the latest developments in conservation technology. No attempt has been made here to turn the librarian into a scientific specialist, but to provide him with as much scientific knowledge as he can reasonably use ; and this purpose, it seems to me, has been satisfactorily fulfilled. The book, an important contribution to the much-talked about aspect of the library science, serves a useful purpose for all whose business is the conservation of printed materials and other media of communication.

5. 7. 1990.

(**Saktidas Roy**)

PREFACE

Books which are the storehouse of knowledge, information, education and experience, serve as a bridge between one country and the other and between mankind from the ancient time to the present days. Library collection is mainly made up of books which can get deteriorated, damaged even destroyed, due to various reasons. Therefore, everybody connected with libraries—directly or indirectly—must have some knowledge about the various scientific methods which may help to prevent such deterioration. Specially librarians and library staff must have comprehensive knowledge about the reasons of such deteriorations and every possible preventive as well as curative measures.

Library conservation should be a part of library science training programmes as a compulsory subject. But, unfortunately in our country, it is not included as a full-fledged subject at any stage of library science curriculum. Practical training in this aspect is almost absent. Even, whatever little is taught as a part of a paper (subject), for the same, not a single Indian book is avaliable where all the aspects of library conservation is dealt with in some detail with special reference to the prevailing situation in this subcontinent. But such a publication has become very much necessary for students, library workers, book lovers in our country.

There are some articles published in different Indian periodicals on some aspects of library conservation. There are two Indian publications in english entitled "Library and Preservation" by Minendra Nath Basu and "Preservation of Library Materials, Archives and Documents" by B. B. Mukherjee.

Both the publications are brief and do not cover all aspects of conservation. Some other Indian books on library science have a chapter or so on this subject.

In this aspect, we can mention about the full-time training programme on conservation organized by National Archives of India at New Delhi, and short-term programmes like "Management Course in Reprography" in 1981, "Management Course in Conservation of Documents" in 1982, both conducted by IASLIC ; short-term training programme on conservation (1982) under the guidance of famous conservation expert and Head of the Conservation Unit of India Office Library, Mr. F. J. Marsh under the auspices of the British Council ; "Training Course in Conservation of Library Materials'' conducted by National Library, Calcutta, etc. At present, there is no full-time full-fledged course in conservation in India excepting the one that is conducted by National Archives of India at New Delhi.

Inspite of our best efforts there may be some errors and omissions in this publication. Authors will remain grateful to the readers who will provide any constructive suggestion to improve the publication in future edition.

At different stages we have consulted various publications which we have tried to include in the bibliography provided at the end. We have taken help from various unpublished notes and reports, some of which are not included in this bibliography as these are not readily available.

Among those, who have inspired us in writing this publication, the first name that comes to our mind is that of late Dinesh Chandra Sarkar, first Librarian of the State Central Library, Government of West Bengal. It may not be possible for us to bring out this publication without his constant inspiration which he extended till his last days. We are grateful to him.

We wish to express our sincere gratitude to Sri Sunil

Kumar Roy, ex-Librarian, State Central Library, Goverment of West Bengal, for his constructive suggestions and inspiration.

This would not be complete without a word of appreciation to Mr. Saktidas Roy, Chief Librarian, Ananda Bazar Group, who graciously wrote the Foreword to this book. We must express our sincere gratitude for his generous help and stimulating inspiration to complete this publication.

It is worth mentioning here that the active support provided by Sri Dhruva Kumar Basu, Sri Shubhabrata Mukherjee, Km. Susmita Mukherjee, Smt. Ila Mukherjee, Smt. Swapna Guha, Sri Pallab Guha made our job comparatively easier.

We have also received active cooperation and support from Sri Nihar Kanti Chatterjee, Sri Sital Das, Sri C. K. Radhakrishnan. We remain evergrateful to them.

We are also thankful to Mr. Suvendu Roy and other staff of Usha Press for their sincere cooperation to bring out this publication in a very short time.

The authors hope that this publication will—

* enlighten each and every library about the importance of conservation ;
* encourage to provide training in library conservation ;
* help the students of library science as well as library workers.

If it can meet these goals, we will deem our effort is successful.

Finally, we want to assure that we are ready to extend our full cooperation to any Institution/Organization in the field of library conservation.

July 24, 1990

Kalyan Kumar Mukhopadhyay
Partha Subir Guha

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What is Library Conservation

The word 'library' originates from a latin word 'liber' which stands for book. In latin 'liber' also means bark, which was one of the materials used for preparation of book in ancient times. During the Roman empire bark was used as one of the main writing materials. The word 'library' as it stands now, in english, means collection of books or similar other literary or artistic material also and the building or a room where books and similar other materials are kept or stored.

The word 'conservation' originates from a latin word 'conservare' which means 'to keep, to preserve'. The action of conserving is to preserve from destructive influences, natural decay or waste ; preservation in being, health, perfection etc. (Oxford English Dictionary. Oxford, Clarendon Press, 1970).

The idea of conservation comes only when there is any possibility for a material or group of materials to face gradual or sudden deterioration of its condition (both internal as well as external) for one or more reasons present in the material and also in its environment. This deterioration may ultimately result in complete destruction of the materials. From this we can infer that conservation is not one single process but a combination of various processes to achieve the goal to preserve the condition of a material in its original form as far as possible. Therefore, the process of conservation may be divided into two parts (1) 'Preservation' in which attempts are made to resist or delay the deteriorating effects of the environment and the like ; and (2) 'Restoration' in which actions are taken to they noticed that those drawings are damaged by sun and rain, and also by other environmental conditions. This experience forced them to look out for newer methods by which the drawings or writings may be more durable. Ultimately they discovered the technique of engraving on stone or on similar other hard surfaces. This technique of engraving on stone was started in the Stone Age, but continued to be in use till more recent times. Emperor Ashok's inscriptions are one of the finest examples of application of this technique in our country in a much later period. Though this engravings give a permanent or near permanent form of record, it is at the same time a time consuming laborious process. This lead them to search for other medium on the surface of which it is more convenient to write with less labour.

Clay Tablet

In search of suitable writing medium, attention was drawn to mud or clay, which was available in abundance in his surroundings. He found that it is very easy to write on clay when that is wet, especially on alluvial soil for its plastic nature. Writing or drawing can be done with dry thin slender branch on wet clay, which is then allowed to dry in open air or sun to turn it hard. It can be further harden by burning it. Use of this new medium brought about a revolutionary change in writing materials enabling one written record to be shifted from one place to another with ease. This facility ultimately gave rise to the establishment of library in due course. But the search for more suitable writing medium goes on unabated.

Papyrus

In the Nile basin of Egypt a weed known as Papyrus grows. Mainly in the Nile delta area, in shallow marsh, where the depth of water is not more than three feet and the water flows very slowly, the papyrus weeds grow in abundance. These are ten to fifteen feet high and at the base about three to four inches wide. The pith of this weed is cut into thin strips which are placed across one another at right angle in two or more layers. Then water is sprinkled over them and allowed to dry in sun. When dry the strips stick to each other forming a sheet which is smoothen to make it suitable for use. Writing was done on it with the help of soft brush. Normally carbon ink or ink made of iron salt are used for writing on this medium which gives a permanent writing. Small pieces of papyrus are joined one after another to form rolls. Some of such rolls are one hundred feet (30.5 metres) or more long. Longest such roll discovered so far is about 130 ft (32·9 metres) long in which the incidences of the reign of Emperor Ramesis II is recorded. This papyrus roll is now preserved in the British Museum Library, London.

Bark

In almost every corner of the world, in one time or the other, bark of various plants and trees are used by people as writing material. In Central Asia, China, India and adjoining areas it was used for a long period. It was used in some areas even in the beginning of last century.

Birch tree (Betula papyrifera) grows in plenty in Himalayan area in India. Various types of birch tree grow in Europe, America, Canada. Alaska etc. During sixth and seventh century in our country, particularly in the regions around Kashmir, use of birch bark as writing medium was very common. In south India, specially in Malabar district, one similar bark was used for writing for very long period. From old historical documents we come to know, that 'bhurjapatra' was one of the main writing material in Ancient India. This was prepared from the barks of a tree of birch family. A birch tree may be 40 to 130 feet (12.2 to 39.6 metres) tall. The upper layer of the bark is brown in colour, while the inner layers are whitish and have paper like texture. This inner layers are used as writing medium. These are usually cut into 90 cm × 120 cm (3′×4′) size for convenience of use. It is also used in various other sizes depending upon the 'users' taste and convenience. Writing was done on it with very soft brush using carbon ink. To make it fit for writing it is slowly dried in air and polished with application of oil on it. Several thin layers of bark are laid one above another and kept under pressure to make usable sheets. Under pressure the fibres as well as the gum present in the bark help the layers to stick to each other forming a sheet. Normally birch bark contain certain chemicals, e. g., salt of salicylic acid which help the preservation efforts. Due to the presence of such chemicals insect attack is rarely found in case of birch bark. But like all other writing materials of vegetable origin, birch bark also absorbs moisture and due to that one sheet gets affixed with the next one. On the other hand in very dry climate, it first bends and then becomes brittle. After absorbing moisture or water, it becomes extremely brittle on drying.

Palm leaves

Palm leaves were used as writing materials almost side by side with 'bhurjapatra' or barks in India and its adjoining countries. It was also used in Egypt for a certain period. Use of palm leaves were very popular during seventh to twelfth century, mainly in Bengal, Bihar, Orissa and in South India, where palm trees grow in abundance. Palm leaves which were used in India can be broadly divided in three groups (a) Tal, (b) Sri Tal, and (c) Palm Tal.

Tal leaves are thick and rough. Ink cannot penetrate its surface. Writing is made on it with sharp metallic needle by scratching (which cuts the upper surface of the leaf). For convenience in reading carbon black mixed with oil is applied on its surface.

Sri Tal leaves are thiner and somewhat flexible like thick paper. Insects do not readily attack or damage these leaves. As these leaves can absorb ink, carbon ink is used for writing on it.

Palm Tal leaves are neither as thick as that of Tal nor as thin and flexible as that of Sri Tal. It is of medium thickness and darkish brown in colour. Ink cannot penetrate the upper surface of the leaves so thin metallic needles are used to write on it by scratching as in case of Tal leaves. In absence of proper preservative care all types of palm leaves are damaged by powder-post beetles and very old palm leave manuscripts often loose their natural oil and become brittle.

Wood

In ancient China, before discovery of paper, wood was the second most used writing material. Thin wood sheets were coated with fine layer of wax and then writings were engraved with the help of sharp knives. Sometimes these wooden sheets were joined with each other by means of thin hinges and a crude form of book was formed, which was called 'codex'. Many religious literature, legal codes of that age are found in this form. Most important enemies of the wooden materials are various insects particularly the white ants (termites) which not only damaged but also destroyed many such documents.

Various other materials which were used as writing material during some period or the other include ivory, bone of various animals, metal plates, leather, cloth etc.

Ivory

Due to very smooth surface, ivory was used as writing material. It is easy to engrave on it which is very stable material—almost permanent. But its high price and limited availability never allowed it to become a popular medium for writing. It is not possible to write on it with ink as the same cannot penetrate its surface.

Animal Bones

In ancient times in some areas various animal bones were used as writing medium. Normally scripts, drawings were engraved on it which were very stable. But it was not a popular medium.

Metal Plates (Sheets)

Various metal sheets were used as writing material all over the world in different period after the Stone Age. The use continued for many years due to its convenience and easy availability. We can trace use of such materials even during last century when Royal orders, declarations, documents related to gifts etc., were recorded on it. From the old scriptures like Jatakas, we come to know that religious quotations, family records etc., were often engraved on gold sheets for storage by the rich businessman of that time. From historical documents we come to know that lead plates/sheets were used for copying Bible. It is believed that complete work of Greek scholar Hesiod (776 B. C.) was recorded on lead plates. The use of metal plates to record historical documents was started during Roman Empire. Lead is comparatively soft material and turns blackish if exposed in open air for a long time, but it do not get damaged by environmental conditions easily, as most other matals do. Except lead, copper is the other metal which was used in bulk as writing material due to the fact that it can be converted to thin sheet very easily, though it is comparatively hard. Acidity of the environment is the main enemy of copper sheets.

Leather

In prehistoric period, when man first learned to hunt animals, he gradually started use of animal skin for various purposes.

From this it can be easily inferred that its use as writing material started in very early stage of human civilization. From ancient Buddhist literature, we come to know that animal skin was also used in our country for writing. In the early stage, man do not know how to convert raw skin to processed leather. There are enough evidences, which indicates that animal skin was in use as writing material during Egyptian civilisation.

Parchment / Vellum

Though the terms parchment and vellum frequently used as synonymous, actually these are two completely different materials prepared from raw skin. Vellum is prepared from skin of unborn or newlyborn (not more than six weeks old calves). The skin is cleared off hair, meat, etc., and then treated with lime solution. Normally parchment is prepared from sheep skin, though sometime it is found that skin of other animals are also used to prepare parchment. Vellum is comparatively more durable, better in quality and more costly than parchment and are used for preparing exclusive costly books/ manuscripts. Parchment is cheaper and much more popular material due to easy availability and low cost.

Cloth

In China cloth, more particularly silk, was most used writing material before discovery of paper. Writing was done on long sheet of cloth with the help of brush. Later one sheet is joined with another and they are preserved in the form of rolls, keeping it in earthern or wooden container with tightly closed lids. Even now, we come across such documents in Tibet and adjoining Himalayan areas in old Buddhist caves. Old documents indicate that around 345 B. C. cloth was one of the most popular writing material in India also.

Preservation of Library Materials : Historical Account

From the ancient time till today the form, shape etc. of a book have undergone many changes. Both the matetial used to produce a book, as well as its external form are everchanging From the prehistoric period, the cave paintings ; engravings on stones, hand-tools, metallic plates ; writings on leather, bark, palm leaves etc. served the purpose of transmitting or communicating the experience, ideas, knowledge of mankind from one era to other. In the modern time gramophone records, audio tapes, photographs, microfilms, microfiche, video tapes etc., are serving the same purpose. Though we can not call them 'books' in strict sense of the term, but they have made their own permanent place in the library. Therefore, whenever we consider seriously the problems of conservation of library materials, we have to think of conservation of all these materials alongwith the conventional ones e.g., books, manuscripts, periodicals etc. But we may have to give more attention to the older materials e.g., clay tablets, papyrus, silk, parchment, vellum, palm leaves, bhurjapatra etc. as their physical condition became weaker due to gradual deterioration through the ages. At the same time, it is true that very few modern libraries have these materials in their collection.

Whatever may be the component of the library collection—problems of conservation are many. With the difference of the materials the conservation problems and their solution varies. The conservation problems are as old as the libraries are. If we study the history of libraries all over the world, we find that libraries came to existance almost at the sametime in China, Egypt and Asia ; and they grew around either royal palaces or religious organisations like temples, monestries etc. These royal and religious patronage was found in China, Egypt, Greece, Rome—everywhere. Even in the days when christianity started to spread gradually, the saints and preachers took interest and also active part in spreading libraries i.e., establishing and maintaining libraries. The reasons behind the royal patronage may be due to the fact that they might have understood that library collaction were more powerful than their collection of most deadly weapons. It may not be irrelevant to mention here about one historical incident in 267 A. D. Goth intruders captured Aegean and looted Athens. But we come to know from various historical records that they have neither set on fire nor destroyed the library. It is said that the intruders believed that the learned people, who use the library, will never be good soilders and so long library is available to them, their attention will not be diverted by anything other than study. The reasons behind this incident may be something else e.g., the library may have failed to draw their attention or these may have seemed to them mysterious and devine as they were not very familiar to libraries, etc. Anyway modern scientists are also of the opinion that thirst for knowledge makes man more rational and of softer mentality.

The libraries of early ages had mainly clay tablets in their collections. The earliest form of preservation problems faced by libraries were the narrow tunnels dugged by insects in soft clay tablets before it get hard through drying. When dried, a new problem appeared—it becames brittle and writing on it started getting damaged by abrasion with any rough surface. To avoid these, clay tablets were handled with care and all possible steps were taken to see that rubbing with any rough surface can be avoided. To achieve these they were kept in big containers with adequate care. The library established by

Sargon I, the founder of the Semitic empire in Chaldea and which was destroyed by fire at the time of fall of Nineveh, had in its collection large number of clay tablets. From various historical documents we come to know that there were about 30 thousand clay tablets in the ancient library at Tellow. One of the most famous library of ancient time, Akkad library in Bagdad also had mostly clay tablets in its collection Babyloneans, who are the inheritors of the Sumerian civilization also used clay tablets. Famous library of Barasippa was established with the collection of about 25,000 clay tablets most of which were copied and collected by the last of the great king of Assyria, Ashurbanipal (668-627 B. C.) to enrich his own library collection.

The clay available at the Nile delta was not suitable for clay tablets and also as a result of never ending search for more suitable medium for writing purpose, use of a weed known as papyrus to make a paper like sheet was started. It was more suitable medium for writing, but was more easily perishable. To preserve these the sheets were attached one after another and then rolled round a wooden piece and kept in a cloth or leather case for storage. From this we can say that conscious efforts to preserve library materials was started about five thousand years ago. One of such efforts began in Egypt in the papyrus age. It can not be said with certainty when and how the use of papyrus along with its preservation techniques reached Greece, but it is presumed that it followed the normal trade route and the traders were responsible for the introduction of papyrus in greece. Soon this became popular medium and within a short time it took the number one position among the mediums used for writing in that country (around 500 B. C.). This can be established from the writings of Herodotus.

The two famous libraries established by Emperor Ramesis II (around 1292-12?5 B. C.) in Thiebes and Memphis had almost all types of materials in its collection which include clay tablets, papyrus, palm leaves, writing on wooden materials etc. (Writing on all surfaces, other than stone engraving, are prone to damage by gradual deterioration – in case of clay tablets by insects and abrasion ; palm leaves, wood, bark, papyrus etc., by excessive humidity of atmosphere, insects, like termite etc. in case of silk, leather etc., by cockroaches, termites, silverfish and other similar insects and rats etc. Damages are also done by extreme weather conditions, dust, dirt and damaging chemicals and other materials present in the environment. In ancient time librarians in Egypt, Greece, Rome and adjoining areas used to keep the manuscripts in tightly closed cylindrical containers made from wood or ivory.

Silk and wood were most popular writing materials in China before the discovery of paper. The wooden pieces or bamboo sheets were also used to record useful information. At that time various herbal products were used for preservation, in China, which confirms that conscious preservation through herbal use was known and practiced by the Chinese even before the discovery of paper in 105 A. D.

In later period, preservation in libraries in Egypt, Greece, Rome etc., become comparatively easier due to use of more stable and durable writing materials e.g., parchment, vellum etc., instead of papyrus. These materials, which were prepared from raw skin and were treated with lime and some other herbal products, which to some extent protect it from the attack of insects as well as from environmental hazards.

With the spread of knowledge and gradual universalisation of education, the production of books and similar other items increased manyfold (which is often expressed by the term 'information explosion'). This incidence is accompanied by newer and more extensive problems of preservation. Even in favourable atmosphere it is not very easy to use a old manuscript and roll it back to its original condition after use. In dry climate tightly rolled parchment manuscripts breaks down in small pieces. Again in too humid weather parchment swells and writing on it becomes fade and almost unfit for reading. These problems forced scholars to look out for more convenient and stable medium through the ages.

Around late 1st century A. D., rectangular pieces of leather were used for writing and then they were stitched at one end to form a crude book like material to facilitate use. In the middle ages the enemies of the library, mainly various types of insects, spread from one country to other following the normal trade routes along with various trade items—from temperate areas of Mediterranean to colder areas of north Europe and again from temperate areas to tropical regions. As a result, many insects originally from China, Asia Minor, Central Asia and adjoining areas found their way in Europe. Some of them perished in the unfavourable atmospheric conditions but others adjusted themselves to the new situation and survived and multiplied. Whenever new problems in library cropped up, conciousness about the adverse situation grew and attempts to solve them increased, as the old saying goes "necessity is the mother of invention". With increase of insect problems, library workers and librarians become more and more conscious about the preservation problems and various ways to get rid of them and they tried to communicate among themselves by bringing out booklets on this subject. One of such publication of that period was titled 'Remedium Contra vermes Librarum' which was published in the thirteenth century. Early documents indicate that even in 993 A. D. librarians of Sabur Ibn Ardashir (in Bagdad) used some type of chemicals to control the attack of termites.

In Ancient China the seeds of cork-like plant is used to prepare a herbal product which is locally known as 'huangneih' and it was used to control insect attacks. At one stage in China by an enactment of law, it was made compulsory to mix this herbal chemical with the pulp for making paper, so that the finished product becomes insect resistant to some extent.

In 1221 A. D. it was brought to the notice of the Roman Emperor Frederick II, that humidity and insect attack damage paper more easily than parchment. He proclaimed that 'now onwards all legal enactment will be recorded on parchment and all earlier ones, which are recorded on paper will be transferred to parchment within next two years'. At that time most European libraries used to apply ceder wood oil to protect library materials from insect attack. In ancient India various material e.g., alum, camphor, black pepper, clove, musk, neem leaves, tobacco leaves and other herbal oils were used on and around books and other materials in library for protection against insects. Wooden boxes are also used for better preservation. Though these herbals can reduce the insect attack but cannot stop it altogether. The information collected about these period indicates that librarians are not only aware of the necessity of preservation against various problems but consciously attempted to achieve the goal of proper preservation. One early document indicates that in the fourth century St. Pacomiras while establishing the first church library for the christians, gave lot of attention on the preservation aspect also.

In the Middle Ages and even after the Renaisance transmission of information was slow and gradual. The educational institutions and research centres were established in far away places. At that time the production of the materials used for preparation of books, the copying system etc., were slow. At that period perchment sheets were sewed to form crude books, which were protected by wooden covers wraped in vellum or leather. By that time parchment had become the main material used for preparation of books. Card board replaced wood for covering books in the early sixteenth century. The use of partial leather binding in place of full leather started, still later—in seventeenh century only. The form of books which are now popularly known as 'paper back' started only in eighteenth century. Just before the appearence of paperbacks, use of paper in covering pamphlets or thin books started.

Towards the end of the last century to bring down the price of books use of cheaper paper alongwith cheap binding started and gradually it became more and more common in use. But prior to that, almost simultaneously with the industrial revolution, there was lot of advancement in the printing machine, which was very useful tool in mass production of cheap publications. From that period books and other publications became truly universal, instead of something which can be possesed only by some wealthy individuals. This universalisation make the use of book and allied materials more and more popular, which ultimately resulted in increase of conservation problems both in number and also in varieties. The total process of change from the days of chained books (when library was meant for few fortunate individuals and was well protected) to the era when the copying of manuscripts started and more selected readers and users found the door of the library opend in front of them and finally the universalisation of literacy and use of books and library took a very long time to complete, actually spread over several centuries. The real universalisation of library started after the Middle Ages—more particularly with the beginning of the last century, with the appearance of printed books it became more convenient to take it from one place to another.

With the increasing necessity the process of conservation have also changed and improved with progress of time. In the Middle Ages the parchment sheets are sewed together with covers made from wooden pieces wrapped in leather or vellum, which protect these books from the adverse effects of weather, insect attack etc. Excess humidity may damage parchment, vellum etc., but some small precautions can help us to fight against such deterioration. Leather which are treated with alum and other herbal chemicals during its preparation, remain unaffected and in good condition even after hundred years. In our country, palm leaves are protected by putting two wooden pieces on two sides of the manuscripts. Normally this type of manuscripts are further protected by putting them wrapped in a special type of red cloth. With the introduction of less costly paper and printing methods, cheap type of binding etc., the production cost of book has drastically came down. All these cheap methods ends up in newer and extensive problems in conservation as these type of recent productions are more vulnerable to unfavourable weather and insect attack. In those cases where more stable and stronger materials are used for binding, it is found that the cover remain intact, though the book may have destroyed by fungi and insects. With the increase of conservation problems the library workers and librarians become more conscious and also active about the necessity of proper preservation. Primarily regular cleaning and dusting, arranging proper light and ventilation, resisting entry of bright sunlight in the library building, adequate use of insecticides etc., are needed to build up an effective conservation system. In the eighteenth century an extensive search began to find out effective insecticides to fight against insects. At that time many research institutions, universities, educational institutions etc., declared prizes and cash awards for newer and more effective systems to fight against deterioration of books and allied materials. Before the end of the nineteenth century excepting the problem of acidity of paper and leather, all other reasons of deterioration were identified and methods to fight these were also found. With the progress of this century more advancements are made in the methods of restoration and preservation.

Use of chlorine in paper industry to make paper extra-white started almost immediately after the discovery of its bleaching ability. If the excess chlorine is not removed from the pulp, the trace that remains in the finished paper, reacts with atmospheric humidity to generate acidity in paper which accelarate the deterioration process. With the increase in demand for paper, it was not possible to depend entirely on rag, jute, bamboo, cotton etc., which have long fibres as raw materials. Use of wood to manufacture cheap paper started inspite of the fact that they contain much shorter cellulose fibres. As necessity forced us to use these new raw materials, it induced lot of new problems in the conservation arena, as wood pulp always contain appreciable quantity of lignin—an alkaloid, in it. Its presence makes the paper susceptible to quick deterioration—initially in form of loosing whiteness and ultimately becoming brittle. Even knowing all these facts, the publishers are using these type of cheap paper in production of books, which causes more problems to libraries.

The conservation problems of the library mainly originates from the defects that exists in paper, ink, the printing system that was used etc. On some cases librarians do not have much to do in selecting certain library materials for library collection (say for instance—a gift from someone, which may be his or her personal collection) ; which causes some problems as in absence of control on this type of situations, librarians can not eleminate the probable causes of deterioration and resist the entry of weak and short-lived materials in the library. But that could have solve lot of headache regarding the conservation problems in the library. It is useless to think about the situation which is non-existant. Let us wait for the day when the society will be more conscious about the conservation problems and its needs, so that raw materials as well as process of production will be selected with a conscious effort to eliminate preservation hazards. Through these helps librarians will face much less difficulties in solving preservation problems. Till then, we have to face the prevailing situation and try to solve it as best as possible with the techniques and resourcess that are available at our disposal.

It may not be out of context to mention some of the relevent information here. In the beginning of this century, American Library Association started a new movement through which they have tried to allow only the durable and properly recorded or written or printed materials to be taken in the library collection. In 1913, they announced special arrangements for preservation of newspapers which are less durable. In 1925, some big libraries informed the publishers of newspapers that it will not be possible for them to keep newspapers in their libraries as they are creating lot of preservation problems due to defective production methods (e.g., low grade paper, inferior quality of printing process etc.). This decision caused some definite effect on the publishers ; on the basis of which, in 1927, New York Times started printing limited number of copies on rag paper, which are ment for library preservation only. Gradually most of the other big newspapers started doing the same thing. These changes were not only done in regards to paper, but also for ink and other materials. From this, it can be easily inferred that if proper publicity is done regarding the conservation problems, every member of the society will extend their hands of cooperation towards the librarians in the hours of need. In the modern time the consciousness about the library conservation is growing rapidly and we should try to utilise this trend fully for the benefit of the libraries. In short, it can be said that though the number of publications were very limited till the beginning of nineteenth century, yet they cause much less preservation problems, as they were made up of more durable materials.

Main Components of Library Collections

To understand conservation problems we have to first find out what are the main constituents of a book. If we take a book and examine it closely, we will find that it is made up of paper, ink (which is used for writing or printing), leather, thread, adhesives and various other materials used for binding and for writing on the spine of the bound book. If we examine thoroughly the main components of book and collect detailed knowledge about them, it will help us to understand the conservation problems and their probable solutions.

Paper

Paper is known to us all. Generally it is manufactured from rags, wood, cotton, bamboo, grass, straw etc. The manufacturing procedure of handmade paper remained almost unchanged since the discovery of paper, barring some minor changes here and there e. g., mechanical pulping process, application of cutting machines to cut the cellulose fibres to appropriate size etc. The process is very simple — first of all, materials with long cellulose fibres e.g., rag, cotton, jute etc., are collected and divided into groups according to their nature, colour etc. Later they are put in alkaline water in big vat and allowed to boil. Bleacher is used to bleach i.e., to destroy the unwanted colours. After properly boiling in a mild solution of caustic soda the pulp is mixed with plenty of water and allowed to stand, so that, the cellulose fibres float on the surface, while excess bleach and other unwanted materials precipitate at the bottom. The floating fibres are removed and are beaten, so that the long cellulose fibres are broken to shorter pieces. At this stage, certain chemicals are mixed with the pulp, so that the paper manufactured from this will be suitable for writing or printing, as the case may be. Now, the craftsmen take the mixture in big special vats (a big sheeve made up of net to hold the pulp) and start shaking it with sufficient care and craftsmanship, so that as the mixture, spread on the vat in such a manner that the fibres get distributed evenly all over the area in almost equal thickness. The vat have wooden frame called deckle on four edges to resist the pulp from falling out of it. After the pulp is properly distributed and sufficiently dried the deckles are removed and after removing the sheet, the same is placed on felt bed with utmost care and covered with another felt sheet. In this way, sheets are placed one above another and allowed to dry up slowly in air. As they go on drying, the sheets becomes more and more smooth. When fully dried, sheets are cut to required sizes and some type of herbal adhesive materials are applied on the surface to make it more suitable for writing so that ink do not spread or smugge/smear on the surface. Till nineteenth century almost all the paper were manufactured in this metthod. The paper produced by using cotton as the main raw material, is known as 'Tulat' in our country.

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From the historical standpoint, we can say that in 105 A.D. a paper like material was produced in China with the use of bark, rag etc. That paper was very soft in nature and absorbent, therefore writing was possible on it with brush only and it is not at all suitable for printing purposes. Some sample of this ancient and primitive paper are discovered in China, a few of which are preserved in British Museum, London. Paper suitable for printing with blocks was produced much later. Probably first block printed book appeared in the ninth century. Paper manufacturing technique reached Japan via Korea from China. By the beginning of ninth century paper technology had developed well in Japan. Use of paper spread to Europe through the traders, who come to China from West and that's why we find that paper reached Samarkand in 751 A. D., in Bagdad in 793 A. D., in Damascus via Egypt around 850 A. D. and in 1100 in Morocco through the route used by the traders of that age. By 950 A.D., papyrus was completely replaced by paper in Egypt as the main writing material.

As the demand and use increased in Europe, factories for manufacturing paper were established. Such factory was first establisned in Spain in 1150 and then the trend spread to various other places. With the increase of number of such factories the technologies used started to improve gradually. Water mark on paper first appeared in Italy. At the beginning, as the availability of paper was very limited, its use was also restricted among few, but from the early thirteenth century, use of paper become almost universal in France and Germany and by next century in England and Holland also, it reached the general public.

With the increase of production of paper, the demand for its raw materials also increased in a quick pace. In 1719 Renair Reaumur in Germany, first spoke about the possibility of use of wood for manufacturing paper. In England, Matthias Koops and in France, Didot also made some experiments in this line. In the later part of eighteenth century, Jacob Schaeffer successfully used bark, vegetable, vegetable wastes, dry grass, algae, soft wood, straw etc., for manufacturing paper. In 1801 in England, Matthias Koops first started manufacturing paper commercially using straw, hay and similar materials.

Lack of expert craftsmen, to keep the paper quality uniform, to meet the ever-increasing demand, non-availability of good raw materials are some of the reasons, why use of machine become more and more common than the conventional hand-made paper manufacturing process. In 1797, paper technician Nicholas Louis Robert first invented a machine, which can produce continuous paper. Later english technician John Gamble and Bryan Donkin made lot of improvements on this machine. In 1812 two brothers, Henry and Sealy Foudrinier in England, and Nicholas Louis Robert in France started commercial production of paper using machine and therefore we can consider them pioneers in this field. In 1809, John Dickinson invented improved cylinder machine. The place of vat (in case of hand-made paper) is taken by moving fine nets. Depending on the need, the length of these nets may be 75 to 800 cm. (30″ to 320″ inches), the speed of its movement varies from 60 to 600 metres (100′ to 2000′) per minute. Towards the end of the net, where the paper becomes almost dry, vacuum rollers are used, so that excess water can be drained out. After this, there are two other types of rollers e.g., drying and calendering roller, the function of which are clear from their names. After passing through all these processes the finished paper comes out of the machine. In the initial stage, as the raw materials used for manufacturing paper by machine were of good quality, the paper produced were also ofvery high quality and are durable. Though Jacob Schaeffer used some soft wood for manufacturing paper and expressed the opinion that there are possibilities of much more extensive use of wood in paper making, no serious effort was made in this respect until 1840 when Frederick Keller successfully used wood dust to manufacture mechanical-wood paper. To manufacture commercially mechanical-wood paper, small amount of pulp of long cellulose fibres is mixed with wooden dust pulp. Commercial manufacture of such paper started in Europe in 1849 and around 1850 in America. Presence of various impurities e.g., lignin, certain adhesives and other materials make this paper less durable. Almost simultaneously another method of paper manufacturing started, the product of which is known as chemical-wood paper. In this method the wood pulp is treated with different chemicals which help to remove various impurities e.g., lignin etc. As most of damaging impurities are removed in this process, the product is comparatively more durable than mechanical-wood paper. The chemical-wood paper manufacturing processes may be of two types — sulphite and sulphate.

Generally pulp made from fur and similar other wood are treated with alkaline mixture of bisulphite and small quantity of sulphuric acid and heated slowly, so that lignin and similar other damaging impurities can be dissolved and easily removed from the pulp, without causing any damage to the cellulose fibres. The resultant pulp obtained is of lighter colour and easily bleachable. This is known as 'sulphite process', use of which is gradually decreasing and is not so popular now a days.

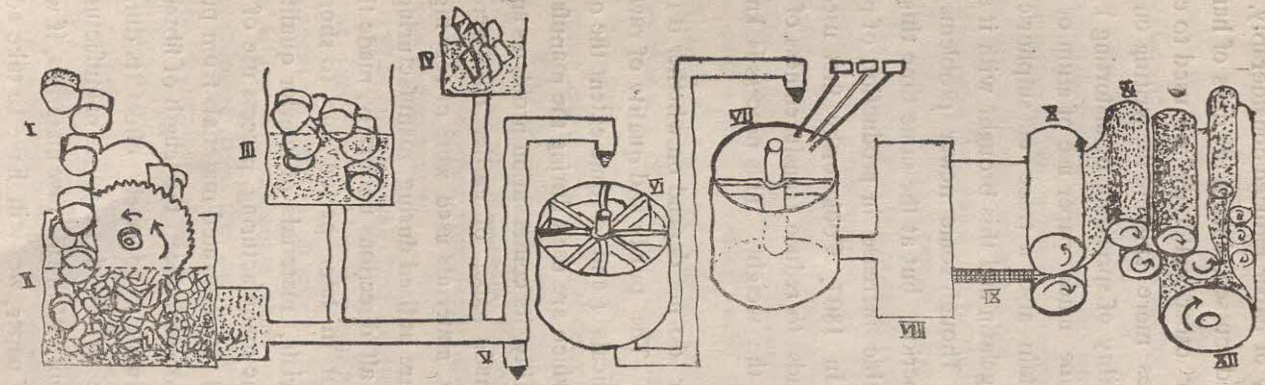
In the sulphate process, pulp made from any type of wood can be used, which is treated with powerful alkaline mixture of sodium hydroxide and sodium sulphate. The pulp obtained in this process is darker in colour and can not be bleached as easily as in case of sulphite pulp. This process is much popular and almost universally used for chemical-wood paper manufacturing. With the onset of industrial revolution there was appreciable increase in the demand for paper which resulted in the necessity of manufacturing large quantity of paper in shorter time at a cheaper cost.

In 1774, chlorine was first isolated and its bleaching capacity was identified. Almost simultaneously its use as a bleaching agent was started in paper industry to make the product much whiter. If adequate care is not taken to wash out excess chlorine from the pulp, any trace left will cause lot of damage, particularly in durability, by reacting with the atmospheric humidity.

In modern paper making technology, in which machines are used, the length of cellulose fibres becomes much shorter, that results in production of less durable paper. In other words, with the onset of use of wood-pulp (both mechanical and chemical) the durability of paper reduced considerably.

As we have already discussed, during the days of handmade paper gelatin or similar other materials are used to coat the paper so that it becomes more suitable for writing on it with ink (without the possibility of spreading or distorting). With the beginning of machine made paper use of alum or similar chemicals (which contain also a trace of sulphuric acid) are started in place of gelatin and this brought with it another conservation problem. Though some newer problems started to appear in modern period, but at the same time this period is marked with appreciable increase in production of paper at a much lower cost. In 1807, Cookworthy first used china clay and allied compounds to reduce translucentness of paper., as well as to increase the weight. This process is known as 'loading'.

Durability of paper do not depend on whether it is hand-made or machine-made. The purity and quality of raw material, and various chemicals (and to some extent the quantity of impurities present) which are used during the manufacturing process effect the durability, its conservation problems and their solutions. The hand-made paper of earlier days were much more durable as the raw materials used were of very high quality and certain procedure utilised during manufacturing, e. g., spreading of fibres in all directions uniformly, made the product much stronger. But in later period due to shortage of high quality raw materials, materials of inferior quality were utilised, as well as in the manufacturing process use of certain chemicals (for removal of unwanted materials from pulp, for bleaching etc.) and processes effect the length of fibres, their strength etc., which ultimately adversely effect its durability. In the present time use of wood in paper manufacture have increased to a great extent. With this raw materials, if we want to have better quality of paper, we will have to take adequate



I. Log Wood ; II. 'Mechanical arrangement to crash wood (chamber contain water) ; III. Arrangements to *convert wood in pulp chemically* (chamber contain chemicals) : IV. Rag, Waste paper etc. (Chamber contain water) ; V. Exit for waste materials ; VI. Arrangement for preparation of finished pulp ; VII. China clay and other chemicals and dyes are mixed with pulp in this chamber (loading, sizing and dyeing are done here) ; VIII. Storage for the mixture ; IX. Pulp is allowed to move over the mesh in vacum ; X. Roller to extract excess water ; XI. Drying Roller ; XII. Finished paper kept in roll.

care to remove lignin and similar other materials (e. g., resin etc.) entirely in case of both mechanical or chemical method. Even existence of traces of these will adversely effect paper durability, which will turn brownish with passage of time and ultimately becomes brittle. In case of mechanical wood paper, it is not possible to fully remove entire lignin, resin etc., as such these paper are very weak and not at all durable. Best example of this type of paper is newsprint. In case of chemicals wood paper, we find that through use of various chemicals these damaging materials are almost entirely removed from the pulp making the product comparatively much more strong and durable.

One of the other reasons for manufacture of less durable paper in modern time is the mass production to meet the ever-growing demand. Now it is possible to identify all the reasons which cause quick deterioration of paper. Efforts are on, to find out ways and means by which these problems can be eliminated without effecting cost and productivity.

Let us now examine all the factors that are responsible for the deterioration of the condition of paper with passage of time. Till the time, when use of wood for paper manufacture started, paper was comparatively durable due to use of better raw materials with longer cellulose fibres. Until 1930/1940 it was believed that all rag papers (with longer fibres) are more durable, but in practice, it was found to be wrong. In 1952, William James Barrow published the results of his long and extensive research on paper, in which he pinpointed the reasons for deterioration and made detail discussions on each of them. According to him use of excessive chlorine, resin, alum etc., at different stages of manufacture, not properly processing pulp etc., cause faster deterioration. He expressed his opinion that with proper and careful processing, it is possible to manufacture good quality paper commercially, at competitive cost from wood pulp also. To remove resin from pulp instead of alum, cheaper alkali e.g., magnesium bisulphate, calcium bisulphate, sodium carbonate, sodium sulphate etc., can be used very effectively. In 1959, for the first time in America such paper was commercially released in the market. In 1960 market started receiving supply of paper which is acid free and have lesser possibility to acquire acidity. In 1980 about 25 percent of the total paper available in the American market was of acid free quality.

Deterioration of paper depends mainly on raw materials used and chemicals that are utilised during manufacturing. Other than these certain other factors like the environment in which it is stored, atmospheric reaction, insects, mould attack etc., also effect physical condition of paper. Except all these, natural aging have its own effect on paper, as in case of other materials.

Basing on the results of W. J. Barrow's research on paper, various minimum standards for paper of different use were determined. If paper is selected for writing or printing, following these standards, then most of the conservation problems will not appear at all. Only a very small percentage of published literature find its place in the library and that is one of the main reasons for which most of the commercial publishing houses do not give much importance to selection of paper of appropriate standard. In our country the question of selection of standard quality of paper do not arise at all, due to shortage of availability of paper in the market. Publishers consider themselves lucky if they can lay their hand on any moderate quality of paper on which they can print, at the time of need.

W. J. Barrow indicated a minimum standard for non-coated chemical-wood paper which can be used for printing ; they are as follows—size of the paper 62·5 cm × 95 cm (25″ × 38″) and weight per ream (500 sheets) 26·23 kgs (60 lbs)

"(1) The paper must be free of ground wood and unbleached fibres.

(2) On the basis of a minimum of 15 test strips from 15 different sheets selected at random from a ream, initial folding endurance of conditioned strips shall average not less than 300 folds in the weakest direction as measured on the M. I. T. tester at $\frac{1}{2}$ kilogram tension.

(3) On the basis of a minimum of 12 test strips (selected as in 2) and tested by 5 tears through 4 strips initial tear resistance of conditioned strips shall average not less than 60 grams in the weakest direction as measured on the Elmendorf tester.

(4) After artificial aging at 100° C(±2°) the average of strips (selected and tested as in 2 and 3) shall not show less than the following fold and tear for the days of aging indicated :

Days	Fold	Tear
12	200	53 gms
24	140	48 gms
36	100	43 gms

(5) The pH of the paper shall not be less than 6·5 at time of manufacture, and after heat aging (as in 4) for 3 days shall show no sharp decline.

(6) Opacity of the paper shall not be less than 90.

(7) Procedures for testing shall follow TAPPI (Technical Association of the Pulp and Paper Industry) unless otherwise indicated."*

The quality of paper improves with the increase of pure cellulose percentage in the pulp, which is technically known as alpha-cellulose content of paper.

In 1898, The Royal Society of Arts enumerated a standard for good paper which states that good paper should contain

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*Barrow, William James. Tentative Specifications for Durable, Non-Coated, Chemical Wood Book Papers, 1960.

60 percent alpha cellulose fibre, the quality of resin used along with normal or slightly acidic alum, should never be more than 1·5 percent, minerals used for loading should never be more than 10 percent and pH level of the paper produced should be at least 6 or above.)

Nowadays, paper containing 95 percent alpha cellulose and which have only about 1 percent copper in it and whose pH level is above 6 is considered as good and durable paper.

Normally chlorine which is used to bleach the pulp do not effect cellulose fibre. If the pulp is not processed properly, certain amount of lignin and some other materials in form of impurities remain in the pulp. Such pulp containing impurities are known as beta-cellulose and gama-cellulose depending upon the quantity of impurities present. Presence of beta and gama cellulose in paper makes it susceptible to environmental decaying factors and deteriorates quickly—best example of such paper is newsprint. The paper made from longer fibres is strong and durable and if these fibres are uniformly distributed in all directions (as in case of hand-made paper), it becomes stronger, but in case of machine-made paper the cellulose fibres are spread on one direction only and so it becomes less durable and comparatively weak. [Different types of chemicals are applied on paper to make it suitable for use. These processes can be divided into two groups, one is sizing and the other is loading. The surface of paper is not suitable for writing or printing, when it is first manufactured ; to make it ready for use, starch or adhesive of animal origin, resin (which is generally prepared by distillation of turpentine specially acetic acid), alum, gelatin, formaldehyde, and also some types of artificial adhesives are applied on the surface and this process is known as sizing. In case of hand-made paper, it is done by immersing the paper in a solution made up of above materials. In case of machine made paper, these are applied on the surface by passing the paper through the chemical mixture before it reaches the finishing roller.

To make paper suitable for printing or writing a mixture of calcium carbonate, china clay, chalk, titanium salt etc., are applied on the surface of the paper—the process is known as calendering. To make paper suitable for finer printing e.g., fine grain halftone printing, multicolour printing etc., calendering of paper is essential.

So long we have discussed about paper manufacturing processes, now let us try to find out various factors including environmental ones, which causes or help deterioration of paper. Let us first study the effects of environmental factors which include humidity / dryness, excessive heat, sunlight, various pollutants (e.g., presence of various damaging gases, dirt, dust and other articles in different forms) etc.

Humidity : If the air is too humid, paper will swell up by absorbing excess humidity and this moisture reacts with various constituents of paper and may form acidity. Damp paper forms a very suitable medium on which mildew/fungi can grow easily, resulting in brownish or blackish patches on paper. In case of art paper or other calendered papers the absorption of humidity makes the calendered surface soft and the pages get attached to each other to form solid blocks, which are impossible to separate or restore. In case of extremely low humidity paper losses its moisture and becomes brittle.

Excessive heat / Sunlight : Paper or book should never be kept in direct sunlight as that exposure will make it yellowish and ultimately brittle after loosing its flexibility. Sunlight damages cellulose. Similar damage are also caused by excessive heat or exposure to strong artificial light. In areas where both summer and winter are extreme (as in case of desert areas) paper gets easily damaged and brittle due to contraction and expansion.

Various airborne gases and other pollutants : In 1898, Royal Society of Arts, London, reached to a definite conclusion that one of the main reasons for deterioration of paper and other library materials are the presence of various pollutants in the environment. The urban air contain appreciable quantity of sulphur dioxide which reacts with moisture and oxygen present in air to form sulphuric acid, which has serious damaging effect on paper and allied materials. Similarly nitric acid is produced from nitric oxide. These acids destroy cellulose and make paper brittle. Various other gases present in air also help to produce acidity in paper and increase the deterioration process.

In favourable conditions paper absorbs oxygen from air and froms cellulose compounds which react with acids resulting in breakdown of cellulose fibres into smaller pieces making it less flexible and brittle. This type of reaction is most common in the mechanical-wood / chemical-wood paper of modern time.

The most damaging result of pollutant air is acidity. The elements of future acidity that remains embedded in paper from the time of manufacture, is much less in comparison to the factors leading to acidity that is found in the environment. The increase of acidity in paper is directly proportionate to increase in humidity and temperature. Once a paper becomes acidic for one reason or the other, it should be treated in such a manner that the acidity is neutralised and its durability is increased. The methods applied for getting this result are known as 'Deacidification of paper' and will be discussed later elaborately.

Dust, Dirt, Smoke etc. : Various air borne solid particles are broadly known as dust, dirt etc. These particles cannot make much damage to paper directly. But its presence expedite fungal attack, acidity etc., in paper. It also effect cleanliness of the library resulting in insect attack. Dirty spots and markings appear on paper. Small silica particles present in air effects the smoothness of paper due to abrasion.

Bacteria/Viruses etc. : Several types of air-borne bacteria and viruses reacts with iron components present in paper, resulting in appearance of brownish spots on paper surface, which is known as 'foxing'. On careful examination it will be found that in these brownish areas acidity is developed rapidly.

Fungi : Spores of fungi are always present in air. In favourable conditions, spores germinate on paper. Fungi damages cellulose for their own nourishment and growth. Comparatively moist and darker environment help quicker and extensive growth of fungi. Such attack makes paper weaker and leaves gray or blackish patches on it.

Acidity in paper can also increase due to use of inferior quality of ink for writing and printing. Handling of paper with dirty hand may also result in increase of acidity due to transfer of acidic materials to paper from hand. Sometimes acidity in book/paper increases due to use of sub-standard leather and other binding meterials.

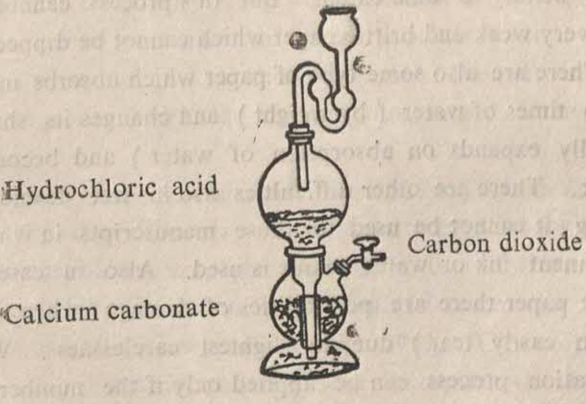
Library's internal arrangements to check deterioration of paper : To check deterioration of paper, eradication of acidity is most important. The first and foremost step to check deterioration is to effectively control the environment inside the library. The elements in the atmosphere (both solid and gaseous) which increases acidity can be removed by washing the air before it enters the library premises. In modern improved airconditioning system along with control of humidity and temperature, this type of washing is also effectively done. In ordinary air-conditioning machine there is no arrangement for air washing. To achieve this, first the air with controlled humidity and temperature is allowed to pass through wire-meshes (where airborne solid particles e.g., dirt, dust etc., are eliminated), and then through alkaline water. The acidic gases and such other materials are neutralised by this alkaline solution. In this process the solution also looses its alkaline nature gradually—to solve this difficulty either the alkaline solution should be changed or fresh stronger alkaline material should be mixed with the solution at regular interval so that the pH level of the solution remains between 8 to 9. The temperature within the library should be controlled between 22° to 25°C and relative humidity around 45 percent, as at that condition the element, in the air causing acidity remain least effective. If possible a paper standard should be fixed, anything below that grade should not be allowed to be added to the library collection.

Deacidification as rectifying method to check deterioration : We know that due to defects in raw materials, manufacturing processes and storage conditions, paper becomes acidic (i.e., pH level comes down below 6 points) causing quick deterioration of paper. One main task of preservation is to destroy the excessive acidity of paper. In such a case use of mild alkaline solution (pH level 9.2) is very effective. Calcium hydroxide and calcium bicarbonate can be very effectively used in this field. As a result of use of these chemicals the paper becomes embedded with small amount of calcium carbonate which delays the future attack of acidity. This can be proved through various experiments (including 'Artificial aging test').

Let us now see, how to prepare the solution of calcium hydroxide and calcium bicarbonate for use in deacidification process.

Calcium Hydroxide Solution : We have to take half kilogram of good quality of calcium oxide and grind it to powder. The powder is now poured in a big glass or porcelain container of 7-8 litres capacity, to which slowly water is added with continuous stirring to make white paste. Heat is emitted when water is mixed with calcium oxide and therefore it is necessary to stir the mixture very carefully. About 3 litres of water is necessary to make the paste from half kilo of calcium oxide. This paste is now shifted to a bigger container of about 30 litres capacity and again water is added to it slowly with continuous stirring till the total mixture come about 25 litres. The mixture is then allowed to settle down, when the clear water from the top which contain various impurities and dust etc., is slowly drained out. To the remaining mixture again further water is added slowly with stirring, as done earlier, to make it 25 litres again, which is allowed to settle for sometime and the clear solution from top is taken out for use in deacidification. This process will be repeated till that time when there will be no sediment left. In this way we can have calcium hydroxide solution several times from the same calcium oxide taken in the initial stage. When it will be found that there is no further sedimentation, fresh calcium oxide should be taken and the same procedure be repeated.

Calcium bichromate solution : We have to take half kilogram of finely powdered calcium carbonate in a porcelain



Kipps Apparatus

or enamel container of 25 to 30 litres capacity and by adding water the solution is prepared. Now carbon dioxide prepared in Kipps apparatus should be passed through this solution for 15 to 30 minutes with constantly stirring of the solution. This will give us the calcium bichromate solution of appropriate strength ready for use for deacidification.

Deacidification by using these chemicals have some difficulties—as in these processes, it is required to keep the paper dipped in the solution of these chemicals for quite long time, which may result in paper damage in form of change of colour or development of weakness etc. These processes are also comparatively costly. We cannot use 'calcium bichromate alone as that is only moderately soluble in water. William J. Barrow modified these deacidification processes so that better results can be obtained. He used magnesium carbonate (which is more soluble in water) instead of calcium carbonate. He also noticed that best and more stable result can be achieved by using mixture of calcium bicarbonate and magnesium bicarbonate. In this process the paper is kept immersed in the solution for a whole night (about 20 hours) as a result some quantity of bicarbonate get deposited on the paper which, when dry, turns to carbonate and resist future attack of acidity to some extent. But this process cannot be used for very weak and brittle paper which cannot be dipped in water. There are also some type of paper which absorbs more than two times of water (by weight) and changes its shape (it actually expands on absorption of water) and becomes very weak. There are other difficulties also in wet deacidification e. g., it cannot be used for those manuscripts in which non-permanent ink or water colour is used. Also in case of very weak paper there are possibilities of damage (when wet, paper can easily tear) due to slightest carelessness. Wet deacidification process can be applied only if the number of paper to be deacidify is very limited and materials are in a loose paper form. This process is not at all suitable for deacidification of large collection of bound materials (books) from the standpoint of both cost and time. In case of bound books, we have to first dismantle the binding, then deacidify the loose leaves—dry them properly and rebound it, which involves lot of labour, time as well as cost.

All these difficulties necessitated to search for quicker as well as cheaper deacidification processes in which this type of difficulties will not appear. As a result, three new deacidification processes were invented—

(1) Smith method (invented by Richard D. Smith, patented in 1970),

(2) Barrow method (invented by W. J. Barrow, patented in 1972),

(3) William and Kelly method (invented by John C. William and George B. Kelly Jr., patented in 1976).

Two things are common in all these three methods-that is, all these are dry methods and are much cheaper and suitable for mass deacidification. Still research are on for finding out better methods.

Barrow Method : Morpholine gas is used in Barrow method. Though by using this system deacidification can be done very effectively, yet this is ineffective in building up resistance against possibility of future attack of acidity. Comparatively the other two systems in which Diethyl zinc vapour or magnesium alkoxide is used, are more effective in this respect.

Smith Method : In Smith method magnesium alkoxide is used for deacidification as well as a preventive for future increase of acidity in paper. Extensive use of this method in Canada by the Canadian National Museum and Canadian National Library was started in 1981. The equipment and arrangement that is available there is capable of deacidifying about 5000 books per week (i. e., in seven days working round the clock).

In this system, the books to be deacidify are first dried in vacuum and then placed in deacidification chamber from where air is pumped out completely. The deacidification mixture—magnesium alkoxide, which is obtained by mixing 8 percent magnesium methoxide with methanol and whose pH level is between 10·5 to 11·5, is forced in the chamber at a very high pressure. The gas in this condition penetrates easily in all the books and a small amount of which remains impregnated in paper even after the books are taken out of the chamber. Excess gas is pumped out of the chamber. Later the books are dried in vacuum and allowed to remain in normal atmosphere, so that it can absorb moisture to regain its original condition and becomes usable. When magnesium methoxide reacts with moisture, it will be converted to milk of magnesia which remains impregnated in the paper to resist future acidity to a certain extent.

William and Kelly Method : In the William and Kelly method the books are kept in the appropriate chamber, the temperature of which is allowed to rise to 45°C so that the books can be dried quickly. Then air is pumped out of the chamber slowly and liquid Diethyl zinc is introduced (3 percent by weight of the books) in the chamber. The chemical vapourise immediately and starts its deacidification job. It takes 3 to 4 days to complete the deacidification, after which the excess chemical is pumped out of the chamber and moist carbon dioxide gas is introduced in its place. As a result of chemical reaction 2 percent zinc carbide is formed and it remains in impregnation state which reduces possibility of future acidity. The whole process takes eight days to complete. The main drawback of this system is that diethyl zinc is a highly explosive chemical which explodes in contact of moist air. Therefore application of this system is possible only under expert supervision.

Out of the three dry deacidification, both Smith system and

William and Kelly system can be used only by very big libraries or group of medium and small libraries forming cooperatives ; as these involve very costly machineries which are beyond the financial reach of small or medium libraries. In these systems cost of deacidification per book is about Rs 80 00 only. Though these systems are very effective in deacidification yet they cannot strengthen very weak and brittle papers.

It can be said that for dry deacidification two things are necessary—one is deacidifying chemical and the other is suitable solvent whose boiling point should be lower than water. There are various chemical solvents which can be used for these purposes but some of them are highly combustible, others poisonous and a few are damaging to human being (particularly effecting skin). Some of them dissolves ink used in books or manuscripts. For these reasons, we have to select both deacidifying chemical and the solvent keeping in view that these should not be damaging and must be safe for use and resultant effect should be very good and permanent.

Other than the deacidification systems discussed sofar, there are other methods by which individual sheets can be mechanically deacidified comparatively at a cheaper cost. The sheets are placed on a moving (conveyor) belt which takes it through dry deacidification chamber,where it is treated and dried before it passed out to next compartment. In these type of systems deacidifying chemical is applied through rollers or by spraying or by immersion in the solution. The chemicals are selected keeping in mind the materials to be deacidified. The most common solution used is either methylene chloride in methanol or tri-chloro-tri-fluro-ethane.

Through experiments, it is established that magnesium carbonate is more suitable deacidifier. It's pH level is between 8 to 8·5 (i.e., slightly alkaline). Its reaction with water or moisture is much low, that is why during its use, we do not have to face problems of sedimentation or blocking of noosles of sprayers etc. It can be stored in a tightly closed bottle for a long time in almost unchanged condition. It can also be stored easily in dry state which can be mixed with methanol to give a 20 percent solution. But there is one inconvenience in it's use, as it is damaging to human eyes and skin. For that reason, one have to be careful and wear gloves and sunglass during its application.

Artificial Aging Test for paper : It is our experience that paper deteriorates with aging. To know how it happens, lot of experiments and investigations are carried out at different centres for very long time. It is an established truth that chemical reactions becomes faster with the increase of temperature (generally with each 10°C rise of temperature the speed of reaction doubles). That is why attempts are made to induce aging effects on paper by keeping it in very high temperature for a short period to know the effect of temperature on paper. which is slow and will take very long time in normal condition. This experiment is known as 'Artificial Aging Test'. During this experiment the chemical nature of the paper, its pH level, physical condition e.g., fold bearing capacity, tear resisting quality etc., are tested by utilising various machines from time to time, by taking out the paper samples from the incubator or heater. As paper can easily absorb moisture, to have most accurate result the test rooms temperature and moisture should be kept within a fixed limit through proper control which is very important.

Though this test is much used now a days for determining durability, physical or chemical nature of paper, a section of scientists—express their doubt about its validity or dependability, as they are of the opinion that though temperature is one of the most important factors in deteriorating the paper condition, still there are also other important factors, like the environmental pollution, moisture etc., and ignoring these factors in this test may not give very accurate inferences / results.

There is another point of controversy related to this test, that is regarding the definition of permanent paper. This test was extensively used by William J. Barrow for his various experiments with paper. After he published his findings, the controversy about its validity re-emerged. Even now various experiments are on to judge its dependability as well as to improve its efficiency. As a result, now a new test is evolved, in which along with the temperature, the humidity ratio is changed to find out the reaction. Also with the advancement of science various extra-sensitive machineries and devices are invented through which it is now possible even to measure the light that is emitted during the oxidation reaction of various particles present in paper.

Effect of heat on durability of paper : William J. Barrow developed a table to show how much temperature is necessary to bring down the fold resisting ability of paper from 219 folds to 65. The table is as follows.

Temperature (°C)	Time (days)	Temperature (°C)	Time (Years)
120	0·4	40	3·5
100	3·0	20	26·0
80	22·5	0	195·0
60	169·0	−20	1463·0
		−40	10973·0

If a paper have fold resistance ability of 100 folds than to bring that down to 50 folds, if 1 year is required at 60°C then treating this as an unit, a table is enumerated by B. L. Browning and W. A. Winks basing on the research papers of Richard D. Smith to indicate relation between the loss of durability and temperature.

Relation between Deterioration of Paper and Environmental Temperature :

Temperature Degree (C)	Deterioration of paper reduced to half (Yrs)
60	1
40	18
35	40
30	88
25	204
22·5	320
20	490
17.5	760
15	1200
10	3100
5	7990
0	21000

INK

Now a days, we come across various types of inks—some are used for writing, some for printing or marking, and others for some other purposes. With the progress of modern paint technology, we now have inks of various shades—from very light to very deep colour and of all the colours of the rainbow—from violet to red. Different types of ingredients are used to manufacture these inks.

Though it is almost impossible to determine with certainty when and where ink was first used for writing or drawing and what was the colour of the first ever used ink. From the various documents discovered so far, we can definitely say, that the use of ink for writing was known in China in 50 B. C. Even in much earlier period, in the days of papyrus, ink was used in Egypt and adjoining areas. Around 1200 B C., during the reign of Wo Wahar some type of picture printing method was known. From different reports, it is known that some types of engraved picture was available, but it is difficult to ascertain whether it was engraved on stone from which it was printed on some suitable medium. We have definite proofs of use of porcelain blocks for printing in 11th century. Even in much earlier times we find evidences of use of various colour paints (inks) in cave paintings. From this, we can easily infer that man started using different colours (most of which were of vegetable and animal origin) from very early time—starting with the prehistoric days. But it should be remembered that in the earliest cave paintings generally liquid colours or inks were not used—instead dry colour e. g., coloured clay, chalk etc., were used.

In ancient time, the most used ingredient for preparation of ink was carbon. Probably carbon ink is the first liquid ink used by man. A form of this ink is known as Chinese ink or Indian ink. Commonly it is also known as carbon ink. Romans call it as "atramentum scriptorum" or only "atramentum". Main ingredient of this type of ink was carbon black, charcoal—with which some type of adhesive, generally gum arabic and water was mixed. In some cases wine or vinegar was used instead of water. Adhesive was used in ink, so that carbon particles can remain uniformly suspended in the ink and do not precipitate. It also help to get the ink easily stuck into the fibres of the paper at the time of writing. Water, wine etc., were used to give it fluidity i.e., liquid state. Information collected so far indicate that ingredients were kept in dry condition and at the time of use, they were mixed together to prepare ink with addition of water or wine. Though carbon ink is probably the oldest type of ink, yet it is the best and also permanent under suitable conditions. Most important character of this ink is that it never fade out in sunlight, high intensity artificial light, or through aging. No ingredient of this ink reacts with paper But it have some drawbacks which are responsible for its limited usage. The drawbacks are—(a) in humid condition it get smeared or smudged ; (b) in contact with water drops writings can be partially or fully washed out. These problems were noticed quite early and Greek physician, scientist and writer Pedanius Dioscorides (60 A. D.) or some of his predecessors, mixed small amount of ferrous sulphate in the carbon ink to eliminate its imperfections to certain extent. The ferrous sulphate within a few days get converted into ferric sulphate and oxides of iron. By addition of this chemical the iron compound that is created, prevent the possibility of complete washing off of the writing by water. As ferrous sulphate is highly soluble, it can easily penetrate in the fibres of the medium (e.g., paper) on which the writing is made. That is why, even if the writing is washed off a light brown trace of the characters remain, which cannot be removed by water.

The ink that was used for drawing and writing in the ancient time was not much different from the one, which are in use now-a-days, from the standpoint of their ingredients, which include carbon black, iron compound etc., mixed with some other materials including adhesives etc. Let us study the adhesives that were used in this field. We find the name of gum arabic among the ingredient of ancient ink. Gum arabic is dried secretion of the acacia tree. These trees grow in comperatively hot climate and do not require much water to develop ; that is why, it is found even in arid regions. Romans, Greeks and other european countries used to import this from Egypt and other arabian countries. Small wounds are created on the stems of these trees, through which gum oozes out and dries in the form of yellowish white beads. The presence of gum arabic makes the flow of ink more smooth by maintaining proper viscosity and resist the ink from spreading or smudging. It holds the carbon black particles and also prevent decay or fermentation of ink to certain extent. It also helps the ink to remain affixed to the medium on which writing is made. Its presence was more essential for writing with pen made up of quill or reed for smoother flow, but not so much for writing with modern steel nibs or fountain pen.

Water was the solvent, most frequently used. Rain water being most pure available water, was very popular. River or spring water was also used, but there were possibilities of sedimentation. As an alternative, in certain cases, wine was used as it makes the writing brighter. Vinegar was also used in some cases.

Apart from carbon ink, the other important type of ink, which was used and are still in use, is made up of iron salts mixed with tannic and gallic acid. Use of this type of ink started few centuries after the invention of carbon ink. In the early ages they were known as "encaustum" and then gall ink. One type of wasp, known as 'Gall wasp' make punctures on the bark of oak trees and lay their eggs. The larvae that emerge from the eggs make small galls on the stem in which they stay, eat and grow. Plenty of tannic and gallic acid are collected in these galls. Just before the emergence of the larvae from these galls, the concentration of acids becomes maximum. If for any reason the larvae leave these galls or die, the collection of acid stops automatically. These galls are collected, dried and mixed with ferrous sulphate and water to produce ink. The chemical which is known as ferrous sulphate now a days, was called as green vitriol, (or only vitriol), salmartis or coppears in ancient time. This ink was more suitable for use and not so sticky as that of carbon ink. Writing with this is permanent and it can be used even with fountain pen having steel nib. But it has some drawbacks also e.g., writing with this ink is slightly lighter and in it sedimentation appears readily. Later some improvements were achieved by adding several chemicals to overcome the earlier defects.

The ink, which we come across now a days, can be divided in two groups,—the black one is the modified carbon ink and those having bluish tinct (shade) are prepared from tannic acid and iron compounds. Sometimes aniline colours are mixed to get the desired shades of colour.

The character of ink depends on the ingredient used to prepare it. An ink can be considered to be good if it has the following minimum standard.

(a) Writing should be permanent and it should become darker within few days of writing.

(b) Flow should be smooth and it should be able to penetrate easily into the fibre without damaging the same.

(c) It should be a liquid and should not be thick as gelatin nor have any sedimentation.

(d) It should not have any damaging effect either on materials with which or on the medium on which writing is made.

(e) Writing should not be sticky and should dry up quickly.

Of all inks, carbon ink is only of the type which do not fade out with aging or on exposure to light. But as it gets damaged by water, it cannot be considered as permanent ink. If proper ingredients and techniques are used to prepare gall ink in which no sulphuric acid is present, the same can be considered as comparatively permanent ink. The colour of ink varies according to the choice of the user. But to be good ink it should have permanent colour and writing with it should be distinct and prominent. What is more important for good ink is that, it should not have any damaging effect on paper. Unfortunately all the inks of modern time have more or less damaging effect on paper. When examining old manuscripts, it is often found that in many cases, the papers are seriously damaged by action of ink—even in certain cases holes are formed on the places where paper contracted ink, the reasons being presence of cidic dye or excessive acid in ink which are added to have bright or darker colour effect. But it should be remembered that in case of ferrous salt based ink, presence of small quantity of acid is essential for making writing prominent, to maintain fluidity and to keep its proper standard. Therefore, there should be conscious effort to keep the quantity of acid to such a limit, so that it cannot damage paper or other medium on which it is used. On analysis, if the pH level of ink is found to be less than 4, then it should be considered as damaging to paper. Whether a particular ink is damaging to paper or not, can be determined through a very simple experiment. A small piece of paper should be kept immersed in ink for about 1 minute, then it will be taken out of ink and allowed to dry at a temperature around 21·5°C to 22°C and 65% relative humidity ; along with another piece of same quality of paper of same size should be examined through the "accelerated aging tests for paper" i.e., it should be kept in a oven at a temperature of 105°C to 107°C for a period of 72 hours. Afier that the two pieces of papers are folded continuously. If it is found that the paper which was initially dipped in ink have lost more than 25 percent of its folding endurance capacity, then it should be considered that the ink is damaging to paper and not suitable for use.

We can take help of another process to find out if the ink is damaging to paper or not. On a piece of paper some lines are drawn with ink using steel nib, so that lines intercept one another. Now the paper is allowed to remain at around 105°C in the incubator for 72 hours. After that the ink lines on paper are examined with needles which is lightly moved over the lines. From this test it can be easily determined how much damage is caused on paper by ink. In case of major damage paper tears at the point where one line intercepts the other even though needle is moved over it lightly.

When in manuscripts, damages are started due to use of acidic ink, arrangement for conservation can be done through special type of deacidification, so that the writing is not effected. Several deacidification processes can be used in this respect, but among them the most used one is Barrow method (which was invented by W. J. Barrow). In this process 0.15% calcium hydroxide mixture and 0.15% calcium bicarbonate mixture is used. The manuscript is allowed to remain immersed in each of these solution for 20 minutes and taken out of the mixture and dried.

Calcium bicarbonate and magnesium bicrabonate mixtures can also be used for deacidification. If carbon dioxide is passed for about 2 hours through a mixtures of 1.5 to 2 gms of calcium carbonate and 15 to 20 gms of magnesium carbonate solution, we will get the calcium bicarbonate and magnesium bicarbonate mixture in which the manuscript can be kept immersed for about 20 hours.

Another mixture which can be used for deacidification is prepared by mixing 42 gms di-sodium-pyro-phosphate, 5 gms potassium ferro-cyanide, 14 gms soda in 4.5 litres of water.

We have so far discussed about deacidification processes in which water is used in preparation of the deacidifying mixtures and therefore these processes are known as wet deacidification and suitable for use only in those cases where water resistant permanent ink is used. For manuscripts, where water resistant ink is not used, dry deacidification process can be used by utilising a mixture of 1.86 gms barium hydroxide in 100 ml of methanol (methyl alcohol) or a mixture of 5% magnesium methoxide in methanol. Other than these, dry deacidification can also be done by using various gases e. g., cyclo-hexylamine, ammonia etc. These different types of deacidification can be applied on various manuscripts depending on their nature and with adequate care so that no damage is done.

It is very important to understand and follow the reactions of ink on paper and weakness of paper due to aging. The reaction of ink on paper differs with the change of nature of ink. In case of carbon ink some type of adhesive is added so that it can stick on the medium on which it is used, but in case of iron based ink this job is done by adding small amount of acid in it. In case of iron based ink the fresh writing appears slightly bluish unless some dye is mixed with it. But after few hours, reacting with oxygen present in air the writing becomes blackish and darker. This phenomenon is expressed as 'writes blue, dries black'. This actually happens due to a simple reaction in which the iron salt converts from ferrous to ferric compound. Reaction still continue as a result of which gallic and tannic acids react and change, making the colour of ink marking from blackish brown to dark brown and ultimately rusty brown with passage of time. But the time taken for this total reaction varies, depending on composition of ink and the environment in which the manuscript is kept. The fluidity of ink, how much it is able to penetrate in paper, the nib (composition) used for writing, the pressure exerted at the time of writing (on which the flow of ink also depend) etc., are the factors, which have direct effect on the speed and intensity of reaction. It is worthwhile to mention here that if writings in ink are dried quickly by using blotting paper, instead of allowing it to dry up naturally, the damage to paper will be more.

How the writing will remain after several years, will also depend on the environment in which it is kept. If the environment is too humid or have too much light, the damage will be accelerated ; similarly if the environment is dark and comparatively dry (but not too dry) the rate of deterioration will be slower. The nature of paper is another important factor in this respect, i.e., if the paper is alkaline then the acidity of ink will be neutralised in a shorter period and the writing will be darker (blackish), as we find in case of writing on alkaline calendered paper, on which china clay is used for calendering.

Sometime it is possible to determine the age of a manuscript by examining the writing, but to do it accurately, is very difficult. In doing this, we have to depend mainly on colour of writing and its reaction with certain chemical agents. In many cases the change of colour of writing cannot be detected by naked eyes, but can be determined by a special type of microscope. There are some chemical examinations to determine the nature of ink used. In case of necessity, microscope can also be used.

(a) A drop of water is added on the ink marking. If the ink or colour is soluble in water the marking will be damaged, but in case of iron based ink or insoluble carbon ink the marking will remain intact. If the writing is closely examined under microscope, then from the rough surface of ink mark insoluble, colourless and fine sandy particles are found, which are indicative of the use of blotting paper to dry up the writing.

(b) A drop of 5% hydrochloric acid is added on the writing, and it is heated well and allowed to cool down. When cold, a drop of 10% potassium ferro-cyanide is added on that. If after 5 minutes the colour turns bluish, then it should be inferred that the ink is iron based. This same test is also to be conducted on the same paper, where there is no ink marking to determine, if there is any iron compound in the paper. In that way it can be determined with certainty the quantity of iron present in the ink.

(c) On the ink marking a drop of 1% oxalic acid is added and after 5 seconds, it is washed out and a drop of newly made bleaching powder mixture is added. By this method markings of ordinary iron based ink will be completely removed. If some marking are still left, then it should be inferred that the ink is probably carbon based. To be very sure about this, another test for such ink should be undertaken. In case of iron based ink older the marking, more will be the time required to remove it.

(d) In ink, the presence of chlorine is usually found in the form of hydrochloric acid or some other metallic chloride. As a result of the reaction with moisture present in air, this chloride from ink gradually moves to paper. Measuring the spread of chlorine from ink to paper, the approximate age of manuscript can be determined. But this spreading is dependent on the quality of paper and moisture present in the environment.

If mixture of dilute nitric acid and silver nitrate is applied on ink markings of the manuscript which converts all chloride compound into silver chloride, which is comparatively less soluble, and that is why remains on paper more permanently. If permanganate or nitrite is used on writing, the colour of the writing fades out considerably. After washing excess silver nitrate with dilute nitric acid, if it is further washed with formaldehyde or hypo (sodium thiosulphate) mixture, the silver chloride present gets converted into pure silver which do not leave any visible markings on the paper. As paper contain chlorine or chloride (which enters at the time of manufactures) a definite decision on the chlorine content of ink from this test is not possible.

Methods to make fadeout writing readable

If the writing becomes too fade due to aging, reaction of oxygen, effect of light or water, it is not possible to revert it to original position without causing major damage to paper. Carbon ink never fades out with aging, which is common in case of iron based or other colour based inks. Sometime it is found that writings of some ink gradually fadeout to reach a stage of almost invisible condition, leaving no trace of oxidation. In case of iron based ink, it is observed that when it fades out, on the ink lines traces of iron oxide is found and therefore, it is possible to make it readable again by utilising any of the following methods.

(a) Ammonium sulphide vapour converts ferrous oxide to ferrous sulphide in which some sulphur grains are also found. If dilute ammonium sulphide solution is applied on writing and excess solution is removed by use of sponge, we can get the same effect. But using this method the writing can be made readable for a very short period, as iron sulphide soon react with oxygen of air and get converted into iron sulphate. The process have also damaging effect on paper.

(b) 2% or 3% tannic acid or saturated gallic acid if applied, will darkens the writing without damaging the paper.

(c) If a mixture of potassium ferrocyanide and small amount of hydrochloric acid is used, it will convert the colour of writing to bluish and the same will be permanent. But later there will be some adverse reaction resulting into appearance of bluish patches all over the paper. The process is more damaging for paper, which contain iron compounds.

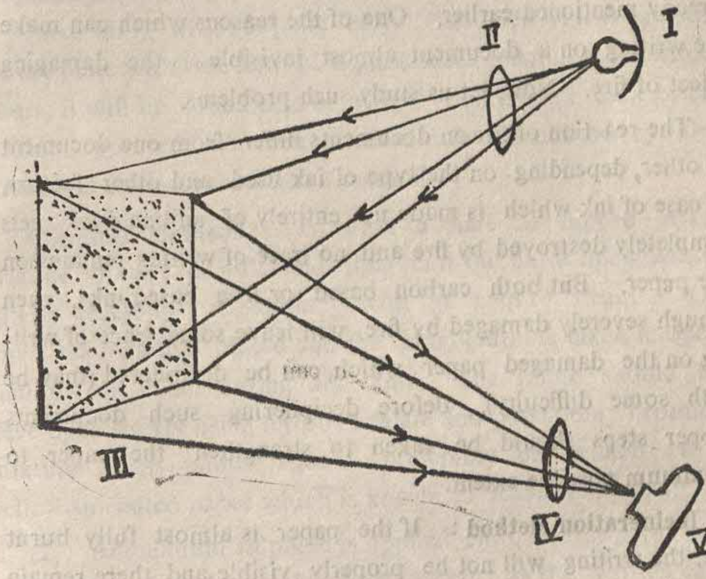
(d) For writing with ink containing sulphuric acid, a mixture of 5% lead perchloride and perchloric acid can be applied which converts sulphuric acid to lead sulphate making the writings more prominent and readable.

If a very faded writing is kept under ultra-violet rays, the trace of iron compound will appear as black marking and facilitate reading. If it is exposed for a very short period for reading, no major damage will be caused on paper.

If small amount of vaseline mixed with mineral oil is applied on the back of fade-out manuscript and the same is placed under ultraviolet rays, writing will appear dark against the bright oily background. Anthracene mixture in alcohol can similarly be used. In ultra-violet rays anthracene will help to make writing visible.

Ultraviolet rays are invisible in naked eyes. Therefore when we read something under ultraviolet ray it is possible only by mixing some normal light with the resultant longer wave length of light makes the writing readable. By this method, photographs can also be taken using two types of of filters— a) one filter which is used between the source of ultraviolet rays and document, which helps to remove all visible lights—this type of filter is known as 'woodglass filter'; (b) the other type of filter which is kept between the document and the camera, will absorb all reflected ultraviolet rays.

Deciphering fadeout documents using Ultraviolet Rays and photography



I. Source of ultraviolet rays II. Woodglass filter III. Document IV. Sodium nitrate filter V. Camera

1% sodium ammonium nitrate solution is used as the filter of of the second type. The photographs are to be taken in darkroom on panchromatic plate or film which should be developed in complete darkness or under green light. In this process it becomes very difficult to properly focus due to reflection of too much ultraviolet rays. For this purpose ground glass and longer light waves (i. e., visible light) are used. But it should be remembered that the focus made by using visible light will never coincide with focus for ultraviolet light. Therefore the focus made for ultraviolet light are made basing on approximate assumption, which may not be correct in most cases.

Methods for deciphering documents with invisible writings due to damage caused by fire

It is possible to make manuscripts with almost invisible writing, readable by some methods other than which are already mentioned earlier. One of the reasons which can make the writing on a document almost invisible is the damaging effect of fire. Now, let us study such problems.

The reaction of fire on documents differs from one document to other, depending on the type of ink used and other factors. In case of ink which is made up entirely of aniline dyes, gets completely destroyed by fire and no trace of writing remains on the peper. But both carbon based or iron based inks, even though severely damaged by fire will leave some trace of writing on the damaged paper which can be deciphered (may be with some difficulty). Before deciphering such documents proper steps should be taken to strengthen the paper to maximum possible extent.

Incineration Method : If the paper is almost fully burnt out, the writing will not be properly visible and there remain no possibility to strengthen the paper. Due to effect of burning the paper becomes black and due to partial oxidation, ink also becomes black and therefore black marking of ink on black background mixup in such a way that they cannot be deciphered. To solve this problem, Mitchel first utilised 'incineration method' in which damaged paper is further burnt to convert it to grayish ash and due to full oxidation of ink the writing becomes comparatively readable. But this method should be employed only as a last resort.

Photographic Method : The burnt out document should be placed on very sensitive photographic plate and allowed to remain in that position in darkness for fifteen days. The paper will react with the sensitive plate, where as ink will not ; as a result the writing will appear on the plate. Films can also be used in place of sensitive plate ; but in that case reaction will be reverse in the sense that ink will react with the film whereas paper will not.

Cherril Method : The burnt out document is first placed on photographic tray ; then 5% silver nitrate solution in water is poured on it, with adequate care. The document is pressed on the plate with the help of a glass sheet. After about three hours, it will be found that on a light background dark black writing appeared. As this method was introduced by Dr. Cherril, it is known as Cherril method.

Chemical Methods : (1) First a plate is dipped in 1% gelatine mixture at 40°C and then on it the burnt document is spread carefully (if necessary with the help of steam). On this a glass plate is placed and the photograph is taken in open sunlight or under strong arc lamp. The photo should be developed slowly using ferrous oxalate and potassium bromide mixture. This photo should preferably be printed on a yellowish coated paper which is known as 'Rambrant paper'.

(2) Ammonium sulphide is applied on the burnt paper and photograph should be taken immediately, as the writing that appears due to chemical reaction, will be very shortlived.

(3) Chloral hydrate and then glycerin is applied on the burnt paper. As a result of the same the writing will be visible and photograph of the same can be taken.

(4) Writing on burnt documents can be read by reducing

the brightness of the same with the help of polarised cover and using magnifying glass, if necessary. Decipheration of writing on documents which are damaged by water can be done using the general procedure of decipheration for general faded documents described earlier. (page 51—3)

PARCHMENT AND LEATHER

Leather is found in the library to play two distinctively different roles—one as a medium on which writing is done and the other as a most important material used for binding. Apart from the standpoint of use, leather differs from one type to other, on the basis of method utilised to prepare them. Therefore, we have to discuss about leather from two different angles separately. Let us first take up the case of leather as writing medium. Of all the varieties that were used as writing medium, the name which comes first in our mind is parchment and the next—vellum.

Parchment

Use of parchment as a major writing marerial, started around 190 B. C. But parchment was first produced much earlier and even about 3000 B.C. it was available in Egypt. It should be remembered that parchment or vellum of that age were not prepared by tanning. Those were then prepared by properly cleaning the skin and then drying it. In the middle ages linseed or similar other oils were applied on parchment to make it translucent so that the same can be used as screen to cover windows.

From a very old manuscript in Egypt, we come to know that occasionally parchment was used as writing material even in 2700 B.C. Oldest such document discovered is now preserved in Berlin and its age is determined as around 2000 B.C. Another such document, which belongs to about 1700 B.C., is now preserved in British Museum, London. But, whether these are actually parchment or other form of leather can only be ascertained by through scientific tests. Though sample of such very old documents are found in Egypt alone, yet various ancient writings indicate that parchment or similar materials were in use also in France, Persia, Central America (notably among Maya and Aztecs) and various parts of Asia.

There is a wrong conception that use of parchment was introduced under the patronage of King Eumenes II around 190 B. C. (probably Plini was responsible for this.) It may be true that during this period lot of improvements were achieved both in its durability as well as its suitability as writing material, and these changes made its use more popular and universal. Greeks and Romans use it in the form of rectangular sheets (cut out of bigger sheets) which are joined one after another and usually stored in form of rolls. Its use started in central, north and west Europe alongwith the spread of christianity.

In the middle ages costly and exclusive type of parchment was prepared from the skin of unborn or newborn calf. This type of material is known as vellum. The word vellum is derived from a old French word 'velin'. Sometime both parchment and vellum are used as synonymous words, which is not correct. Some believe good quality parchment is known as vellum and this opinion is supported by various ancient documents.

In preparation of parchment, the raw skin is allowed to to remain dipped in lime water for about three days after which hairs are removed from the skin using blunt scraping knife. In the next step, they are allowed to dry keeping them properly stretched on wooden frames under tension. When fully dried, further lime is applied on it by rubbing to remove moisture and fat. Finally with sharp knife it is scraped to make it smoother as well as thinner. If required the writing surface is made smoother by rubbing with pumice stone. From the very ancient samples, which are discovered till now, it appear that parchments of that period were comparatively thicker to those of later period. In later period, we find that in case of very thick skin two or three layers are cut out to make them thinner, of which the upper one (which have the hair roots in it) is used for binding purpose, whereas the other layers as writing medium. Sometime salt is also used in manufacturing parchment. There are evidence of use of some types of herbals in the later stage of its manufacture. Even now-a-days, parchment is prepared following almost the same method, the only differences are the use of sodium sulphide in place of lime, use of machine (for cutting out thin layers) and of furnace (to heat, for quicker drying). It is worth mentioning here that the use of lime make the parchment produced alkaline in nature and this help it to remove comparatively unaffected by atmospheric acidity.

Though different documents indicate use of skin from verious animal origin for preparation of parchment, yet from investigation, it is found that mainly skin of goat, sheep, calf are used. In comparison to leather, parchment can absorb more water and get damaged in the process. Therefore, parchment should not be washed with water under any circumstances. In case of extreme necessity they can be cleaned with wet sponge and then quickly dried in dry atmosphere.

The most suitable condition for preservation of parchment is 15° to 20°C temperature and 45% humidity. If parchment becomes almost brittle, due to extreme dry condition, then it should be kept between two moist blotting papers so that it can regain its original condition by absorbing moisture from the same.

Leather

Tanning : Till the end of last century, leather was the most used item for binding. Leather is prepared by tanning, in which raw skin is first cleared of hair, flesh etc., and then processed. Even thousand years ago, tanning was known, in which some herbals were used. At that time alternative layers of raw skin and herbals were put in big vats which were then filled with water. After few days the herbals were replaced by fresh ones. The main chemical content of the herbals—tannin, reacted with the protein of the skin to drive out all its water content and its molecules get rearranged. Thus the skin was tanned and a flexible, more water resistant. usable leather was available. The total modern tanning system, is divided into several steps. In the first step, the skin is cleaned of hair, traces of flesh etc., and then it is allowed to remain dipped in vegetable extracts for a certain period, after which they are taken out and allowed to dry up to make it usable. The whole process to make good quality of tanned leather required about 19 months in the ancient days, but the finished leather obtained were of very high quality which were very strong and durable and comparatively much less effected by atmospheric pollution and other damaging materials. Actually at the time of tanning in this method, certain chemicals from the herbals get embedded in the leather which protects it from deterioration in future from adverse atmospheric conditions. But during the last century, the demand for lea-increased many-fold and the old slow tanning process became unsuitable for the age. To meet the demand of the age new processes are introduced in which various chemicals are used to produce very bright leather in comparatively much shorter time. But as regards quality, this product is definitely of inferior quality in all respect.

Raw skin can be made usable by two other processes other than tanning. These processes are—Towing, which can also be termed as chemical process and Chamoising, which is processing of raw skin with application of oil.

Chemical processing (Towing) : This is a very old leather processing method. Raw skin is dipped in a mixture of 3 parts of alum and 12 parts of salt, for about 10 to 15 minutes and dried. Normally skin of goat and sheep are processed in this manner. The finished leather obtained by this method have whitish colour and can easily be coloured, but its surface remains slightly rough and its texture never becomes very flexible. After processing it is softened by pulling backward and forward in different directions. But leather obtained in this process cannot strictly be termed as finished leather, as if this is subjected to through wash in hot water, we will get back the raw skin again. That is why this type of leather should never be washed with water for cleaning. If necessary this should be dry cleaned.

After 1884, there is a revolutionary change in this method with the beginning of chromium salts use. Later, various other chemicals are also used. Calf skin and other water resistant skins can also be processed in this system. Leather processed by this method can be used in making shoes, garments etc. This type of leather is very durable and never gets brittle i. e., attacked by red rot. Leather processed by using chromium compound never get damaged even by boiling water. But this leather is not suitable for book binding and it never have a perfect white appearance. During last 20 years chrome process became the most popular processing method. Now a day zirconium and other synthetic compounds are also used in processing, to obtain white leather which is washable.

Chamoising or processing of leather with application of oil : This process is in use since the middle ages. To process leather in this system, the raw skin is first cleaned of hair and also of outer layer so that oil can easily penetrate the skin. After that cod-liver oil or similar other oil of marine animal origin is sprinkled and then beaten, so that oil penetrate the skin evenly. This is repeated several times and then allowed to dry, keeping it in a warm room. At the time of drying in warm atmosphere oxygen reacts with the oil and the fibers of the leather. Later, the leather is washed and dried again. In the present time, sheep leather is processed by this method, but in earlier days deer skin was also processed by the same method. Leather processed by this method is slightly yellowish in colour but is very strong and durable and do not get damaged by red rot. They are used for manufacture of garments, bags etc. This leather can be easily washed with water without any damage.

Since 1813, gradually use of sulphuric acid and acetic acid started for cleaning the skin from hair and traces of flesh etc. From 1875 use of herbal product for tanning stopped completely for quicker production of leather with the use of strong chemicals. Leather obtained by these quicker processes are more suitable for dyeing with aniline dyes. But use of this leather in library materials started various conservation problems as the traces of acids that remain in the finished leather start damaging reactions soon, resulting serious deterioration and complete decay within several years. These weak leather cannot withstand the attack of acid which is present in the atmosphere and as a result turns dry, rough and ultimately brittle.

Leather suitable for book-binding

In the eighteenth century mostly calf leather was used for book-binding as they were easily available and also suitable for decorative works. Leather available from processing cow hide* is harder and thicker ; therefore, it is cut into 2 to 3 layers, before they are used. Pig skin is very thick and hard, therefore can be used only in case of binding oversized books. But this leather is very durable and remains unchanged for many years.

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*Skin include skin of small or young animals e.g., calf, pig, goat, sheep and also birds and reptiles. Hide include skin of larger animals e.g., adult cattle, horse, buffalo etc.

There are various types of leather obtained from goat skin such as morocco, nigar, cape, persians, levant etc. All these are of very high quality and extremely suitable for binding work. These are flexible and durable, but costlier and if processed with herbals, remains in good condition even for centuries. It is possible to dye them in exclusive colours and designs.

Other than calf leather, sheep leather is the next most used material for book binding work, as it is also easily available and cheaper too. In the first half of last century when production of mill made cloth was not started and paperback books were not known, sheep leather was the most used binding material. It is flexible but not very durable and not suitable for exclusive and costly binding. In appearance it is very much similar to that of goat leather but are cheaper and therefore, it is used as alternative and sometime also to adulterate for the costly leather by unscrupulous traders.

Protective measures for various library materials of leather origin

There are several leather protective measures that are followed in libraries. Generally wax is applied to protect leather used in binding only. These wax may be of six colours —white (for leather-coloured products), blue, black, red, green and maroon. For very fine and good quality of leather white wax is used and other coloured wax are used for the appropriate coloured materials. Small quantity of wax is taken on a fine soft cloth and applied on the leather with very light pressure, so that a very thin layer remains on the surface. In about 15 minutes the surface dries up and on polishing the surface takes a shinny look.

Different types of leather protective mixtures are used in big libraries all over the world. These mixtures are known by the name of the organization e.g., British Museum, Indian National Archives, Library of Congress etc., in which it was first used or who have first formulated it. These mixture protects leather not only from the attack of fungi and insects, but also from the harmful effects of environmental pollution, light etc.

British Museum Leather Preservative Mixture : The following ingredients are used to prepare the British Museum Leather Preservative Mixture—

Hexane	312 gm.	(11 oz)
Anhydrous Lanolin	198.5 gm.	(7 oz)
Cedarwood oil	28.4 gm.	(1 oz)
Beeswax	14.2 gm.	(½ oz)

Hexane is a petrochemical substance and used as a solvent. First, wax is mixed with hexane in warm atmosphere. It should be remembered that hexane is very volatile and highly inflammable substance, therefore extreme care should be taken, so that it never come close to or directly in contact with exposed flame. Next, cedarwood oil is added with it. Finally slightly warmed anhydrous lanolin (to make it liquid) is added. Before each use, the mixture should be thoroughly shaked. As lanolin is a waxlike material of animal origin, it is absorbed readily by leather, making it soft and smooth and resistant to future decay. This mixture is a thick gelatinous mass at normal temperature and if not used properly with skill, it will leave some markings on the surface. Small amount of wax is added to help the polishing and to resist cracking of the surface and red rot, particularly in case of vellum binding. Cedarwood oil is a well-known preservative and it help to mix the wax and lanolin properly in the mixture. Hexane is selected as solvent as it dissolves and mix with beeswax readily.

Before applying this mixture to the leather spines, they should be thoroughly cleaned, if necessary, with soap water and then properly dried by keeping it in a warm place for two or three days having dry atmosphere. Then the mixture is applied on it by light rubbing. As a result the leather takes a oily appearance. Within about 48 hours, lanolin gets absorbed by the leather and extra oily appearance vanishes. Then it can be easily polished and make shinnuy.

Indian National Archives Leather Preservative Mixture : This mixture is very much similar to that of British Museum mixture from the standpoint of its ingredients, as well as its applications. There are, however, some differences in the proportion of various chemicals used. Here benzene is used in place of beeswax. The ingredients are as follows :

Hexane	312.0 gm.	(11 oz)
Cedarwood oil	28.4 gm.	(1 oz)
Anhydrous Lanolin	255.0 gm.	(9 oz)
Benzene	14.2 gm.	(½ oz)

American Library of Congress Leather Preservative Mixture : This is most popular and most used mixture all over the world. It is prepared with the following ingredients :

Neat's-foot oil	718.8 gm.	(25 oz)
Anhydrous Lanolin	354.4 gm.	(12.5oz)
Japanese Wax (pure)	283.5 gm.	(10. oz)
Sodium Stearate (dust)	71.0 gm.	(2.5 oz)
Distisled water	1275.8 gm.	(45 oz)

First neat's-foot oil. wax and lanolin are taken together and gradually heated. In a separate covered container sodium stearate is added in water and also slowly heated so that it get mixed thoroughly. When both mixtures are ready, in the first mixture which is gradually heated, the mixture of sodium stearate in water is slowly added. At the time of mixing whole mass should be stirred continuously to get a thorough homogeneous mixture. Then the mixture is allowed to cool with continuous stirring so that, the two mixtures do not get separated. When cooled, we get the whitish paste like mixture which should be stored in a covered container. It should be applied in thin layer on leather using soft cloth or broad soft brush.

Role of Printing in Library Conservation

In the field of library conservation, other than writing materials like paper, ink etc., printing also plays a distinct role. Printing denotes exact reproduction of writing, drawing, picture or similar such materials.

History of printing is almost as old as the history of paper. As the invention of paper, printing was also started in China. It was known in China in 2nd century A.D. To complete the printing process, we need three different materials, e.g., (a) paper or similar material on which it will be done ; (b) ink or colour ; (c) block or similar such object on which the matter or drawing is embossed/engraved in a reverse manner.

It is believed that first 'printing' was done by applying some type of coloured material on stone (marble) wall with embossed design and then pressing on it moist paper or some such material. As a result of that, the impression of engravings on wall was transferred in reversed fashion We find proof of use of seals in ancient civilizations like Harappa and Mahenjodaro. This can also be broadly considered as a stage of one form of printing.

In China wooden blocks are produced for printing by first writing or designing the required text on wooden blocks coated with thin wax, then engraving the same with a sharp weapon e.g., a knife or chisel. The main benefit man derived from the discovery of printing, is the ability to get quick multiples exact copies of a document. The sample of earliest printed material is discovered in Japan which was probably done sometime around 770 A. D. But the first printed book with year of printing indicated on it, was the famous translation in chinese of Buddhist religious literature known as 'Diamond Sutra'; it was printed in 868 A.D. This was discovered in 1900 from Tun Huang area of Turkistan in China and now preserved in the British Museum, London. In this type of early printing, separate blocks were prepared for each page from which the printing was done. Like all other technologies, in the field of printing also, there were lot of experiments and tests. As a result of these, printing with movable types was started in China for a short period but there was not much progress at that time. The main reason behind this may be the large number of 'alphabets' used in chinese written language. From that standpoint roman or similar other european alphabets are more suitable to the movable type printing system. In the thirteenth century the Korean Emperor Htai Tjong ordered and patronised manufacture of metallic types (1403 A. D.). But the modern printing with movable metallic types was started in Europe. The use of movable metallic type did not make much progress in China or Korea or adjoining countries in Asia as the type of printing machine to be used for this purpose was neither available nor modifications to earlier machines to this newer use was done.

There are evidences which indicate that, in 1430 A. D. printing with movable metallic type was known in Holland, but achievement of Johannes Guttenberg in this field was magnificent. He not only achieved near perfection in manufacturing movable metallic types but also made various modifications in the printing press to make it more suitable for use in the newer applications. In addition to all these, by establishing his own press, he was able to introduce this new technology to the society. Among the printed books of that period 'Forty-two Line Bible' is very famous. The printing machines used during Guttenberg's period were made of wood.

During the next 300 years after Guttenberg, the printing machine as well as printing technology had changed tremendously resulting in various achievements e.g., assuring equal pressure all over the paper surface, uniform spreading of ink, quicker and better printing etc.

Metallic printing machine was first manufactured in 1795 in England, which was an appreciable step forward in the field of this technology. In 1814, first successful use of rotating cylindrical roller (on which the types are attached by special means) to have printing on both side of paper at a time, was possible and one such machine was engaged to print London Times. Gradually this machine was further improved to give automatic rotary machine in which it is possible to get continuous supply of paper from rolls and after printing, papers get cut and folded to its specific size and come out in a ready to deliver format.

In spite of all these improvements in printing machines, it was not possible totake mechanical help in the field of composition until the beginning of last century. In Boston, William Church devised a machine (in 1812) in which with the help of a key board, the required types were casted, so that, they are readily availble for composition. As the required types were available readily, it was possible to justify quickly by reducing or increasing gaps between words as required. This is the predecessor of monotype machine. Later this machine was also improved through various additions and alterations. Many experiments and search for more suitable and quicker composing machine gave us the 'Linotype machine', using which instead of individual types, one full justified line can be casted as an unit. In 1880, German technologist Ottmar Margenthaler, who settled in U.S.A. invented this machine. In 1885, Tolbert Lanston of America first manufactured monotype machine in which the types are casted in unit form and the composition is done by the machine itself. In modern monotype machines a type of paper roll is used, by punching which the types are selected for casting. Monotype machine was much more speedier in comparison to linotype. In linotype 7000 letters can be casted per hour, whereas monotype machine can compose 12000 letters.

As the development and improvements are going on in the machine front, the printing techniques are also subjected to various changes. In the earliest period all designs and diagrams were engraved on wooden blocks and were attached to the text portion of the page and were printed together. Printing in this fashion is known as 'Xylography'. Then came the new technology in which it was possible to get the picture etched on metallic plates in form of very small shallow holes. When the ink is applied for printing on the metallic surface different part of the plate holds different quantity of ink depending on the various stages of etching on the surface (before printing excess ink is removed from the surface with the help of metallic ink remover) and that gives different shades on paper after printing. With proper pressing the image comes very·sharp. This method is known as 'Intaglio'.

"Oil never mix with water properly", depending on this scientific theory 'Lithography' printing process was invented in 1796. In this, a special type of very smooth stone is taken on which the design is drawn in oily ink or colour ; then the surface is soaked with water and prints were taken using printing ink. Subsequently, the stone was replaced by zinc sheet. To have lithographic prints special type of machine is necessary.

While experimenting with lithography for its improvement,. Joseph Nicephore Niepce in 1820 noticed that there are some chemicals which are photosensitive i.e., sensitive to light. From this came a completely new process or technology which is known as 'photography' or printing image by use of light. Since then in this field, lot of improvements have been achieved.

In 1852, British scientist William Henry Fox Talbot first manufactured metallic block for printing by using photosensitive chemicals on metallic sheet. This system is known as 'Photo-etching'. Later in 1880, by keeping two glass sheets having parallel lines on them, crosswise, one above another and then passing light through them to have the photographs for block making, a new process developed known as 'Halftone' reproduction.

When the attempts to improve the lithographic process was going on, in 1878, the first machine suitable for offset printing was invented ; it was then used primarily for printing on thin metallic sheets. Later printing on paper using offset technology was also started with some modifications in the machine. In this system at the time of printing, the blocks or types never come in direct contact with the paper on which the it is done. The print is first shifted on a rubber coated roller from which it is transferred to the paper.

In 1904, American printer I.W. Rubel introduced a major improvement in the offset machine by using three cylinders. Through further developments in later period, it is now possible to have much faster and better printing from modern offset machines.

In 1929, a machine known as 'Tele-typesetter' was invented, which was capable to get a ribbon punched indicating different types ; and with the help of another machine, it was possible to get words cast and justified in line form very easily as well as quickly. The speed of this machine was 20,000 letters per hour.

In 1950, three scientists in France jointly worked to introduce a system in which computer helped the tele-typesetter machine to compose at a much higher speed of about 3,00,000 letters per hour. In this new process the computer can determine the length of each line and if necessary divide the words and do all other allied works. Later in 1960 the ribbon was replaced by magnetic tape and this change resulted in further increase of composing speed to about 36,00,000 letters per hour.

After the invention of photography, experiments were started to find out, if this new technology can be used for printing with better results. But no major progress was possible in early days. Though in 1915 some application of photography in the field of composition was done, it was in 1947 and subsequent years that saw quick developments of effective and useful application of photography in printing technology. As a result, we are now able to compose neatly and at a much higher speed without using metallic types, through photo-composing machine. In this machine (which looks much similar to linotype or monotype machine with key-board) instead of arranging types photos are produced. In advanced models of this machine, we find that movable parts are reduced through the use of magnetic tapes and as a result in future it will not be difficult, with certain improvements of technology, to compose at a speed of even 3,00,00,000 letters per hour.

It should be remembered that only faster composition can not effect much progress in printing technology ; therefore it is necessary to introduce much speedier printing techniques. Now with the application of cathode ray, radio-waves, microwaves, statical electricity etc., faster printing is possible.

One major invention of modern time in the field of printing is 'Xerography'. In 1938, this was first invented and since then lot of improvements are achieved in this field. But its application is limited to smaller number of copies only. It is now mostly used for getting quick copies for research purposes, office use etc. Detail discussion about this method will be done at a later stage.

So far we have tried to get a birds-eye view of the printing technology and its developments. Now let us examine it from the library conservation standpoint. The wooden block or types used for printing in very early days were not of very high standard and so the paper was physically damaged due to sharp edges, uneven pressure applied by wooden printing machines etc. With the introduction of improved metallic types and printing machines, the chances of such damages had reduced to a great extent. With the introduction of offset machines, as the contact with metallic type surface was eliminated, the chances of physical damage became negligible.

Similarly inks used for printing in earlier days were fairly acidic in nature. In later period it is possible to eleminate the acidity of ink without effecting its printing quality and thus the possible cause of physical damage on paper is reduced.

Ink used in printing industry

Printing ink consists of three different parts like other inks e.g., the carrier or the liquid part, adhesive and the dye or colour. The function of liquid part is to help the ink to spread on the surface of the block or types. Generally the main constituent of this part is of vegetable origin which can easily penetrate the medium on which the printing is done e.g., paper and dries up quickly. Now a days instead of vegetable oil some other solvents like kerosene oil or other petrochemical substances are used. The liquid part of the ink mainly helps to make the print permanent and durable. In case of vegetable oil, it dries up by means of oxidation with air, whereas the petrochemicals dry up by evaporation.

The colour of ink remains in the form of pigments. These are mostly chemicals which are insoluble in water but partly soluble in other solvents. Sometime various chemicals are also used as colour, which are soluble in water as well as other solvents. Other colouring materials are mostly powdered aluminium on which there are thin layers of various coloured chemicals. When adhesives are added to the above referred components ink is prepared.

The composition of ink differs depending on the medium on which printing will be done and the printing technique which will be used. Generally the ink used for letterpress and offset printing are slightly oily and sticky in nature. In this type of thick ink, vegetable oil is used with which natural or artificial resin is mixed. The ink that is used for rotary machine is lighter and based on mineral oil.

Among all printing inks of various colour, black is most used. The main source of black colour is carbon black which is manufactured by burning natural gas or oil in a controlled condition. To get other colours, compounds of various metals are used e.g., compounds of iron, calcium, chromium, molybdenum etc. Generally the coloured ink for offset is of much brighter colour in comparison to those used for letterpress printing and it do not have any reaction with water.

In case of both letterpress and offset printing ink differs for different type of job . For very bright printing the ink which is used, contain artificial resin along with lead and cobalt compound. The printing with this ink get brighter after drying. In some type of ink, such solvent is used, which makes the drying quicker. The ink used in xerography (dry ink or tonner) gets permanent with the application of heat. In foreign countries ink used for printing food packets are of special odourless type which contain such pigments that penetrates and get permanent with moisture of the paper. For printing the food packet, the ink should be selected very carefully, so that it do not contain any component which may be harmful for human body or result in food poisoning. There are some other special types of ink used mostly for advertisement printing, which glows in darkness and known as fluorescent ink. Ink used in flexography contains alcohol as solvent.

Due to some special situation since the end of seventies there are some major changes in the field of ink technology. The economic situation, high cost of petrochemical substances, various government regulations etc., are the main factors behind these changes. The wave of changes are still continuing. The regulations to prevent atmospheric pollution have also resulted in change of the composition for some of the inks used so far.

Special type of paper for offset printing

Paper must have certain specific qualities to be used for general printing or writing purposes e.g., smoothness, ability to absorb ink, ability to stand the pressure required for writing or printing etc. But for some special type of printing other than these qualities, paper should have some additional characteristics. As for example, the paper which will be used for offset printing, should be stronger than usual printing paper as this paper will be moisten in the printing process and will be subjected to more pull and tension between the rollers, which are absent for normal printing. If the paper is not strong enough, it will be damaged at this stage. The paper for offset printing should be such that it do not absorb excess moisture and be smooth enough on the surface but should not have any coating on it, which can hamper printing process by getting transferred to the rubber rollers. The paper should also be homogeneous in nature. So that all the surface can take equal amount of moisture, which is essential for smoother printing.

Enemies of Library Collection and Protection against them

The materials that we found in the library collection are mostly made up of either vegetable or animal origin. Due to the effect of environmental conditions these materials can easily be damaged. In natural course vegetable products changes slowly with the passage of time and this property causes serious problem for library in form of deterioration of physical condition of the collection.

The main function of library collection is to provide information/knowledge to the reader/users. If this function is effected due to physical condition of the collection, we can consider that as damaged condition. These damages may be of three types—chemical, physical and biological. None of these damages should reach such a stage that they can effect the library services adversely.

It can be easily inferred that the conditions responsible for these damages are present in the immediate environment of the library collection both within the library premises and outside it. In most cases it can be noticed that certain materials that are present within the library environment is responsible for the deterioration of the products of vegetable as well as animal origin. The location, housing structure, construction and weather condition of the locality determines the materials, which will be effected / damaged / destroyed and up to what extent. In a vast country like ours, where we come across diverse types of weather e.g., extreme hot desert area, very cold mountain ranges, regions having prolong rainy season etc., the problems varies from one area to the other. It will be a futile exercise to find out similarity between the problems faced in desert areas of Rajasthan with monsoon effected areas of south 24 parganas in West Bengal ; or between the snowy regions of Kashmir with that of rain drenched Kerala. As the weather, the problems of the libraries also differs from area to area, as for example—in desert areas we find problems of abrasive effect of sand caused by dust. The same dust causes fungi / mildew problems in rain effected moist weather. Similarly the dust in metropolitan areas, like Calcutta, contain minute particles of various chemical pollutants which causes damage to paper, leather and similar other materials causing acidity apart from its abrasive and fungi growing effects.

We have already indicated that the damages can be physical, chemical or biological. It should be noted that one and the same material may cause more than one type of damage e.g., water (humidity) helps leather, parchment, vellum, paper etc., to swell up—physical damage ; activate chemicals present within these materials specially in paper resulting in production of acidity—chemical damage ; or can prepare an environment suitable for the growth and spread of fungi—biological damage. Though growth of fungi is considered as biological damage, but ultimately it turns out to be a physical damage.

The deterioration of library material is a complex problem. The physical strecture of the library materials in most of the cases contain the seeds of future damage, which either individually or collectively can start the process of deterioration. To prevent such problems, librarians and library workers must first understand the reasons and the processes of deterioration.

The most common reasons behind deterioration of library materials are as follows—(1) Weather, (2) Excessive heat, (3) Humidity, (4) Light, (5) Various gaseous pollution—smoke, (6) Sand, dust, dirt, (7) Fungi, bacteria, viruses, (8) Insects, (9) Rodents and similar other animals, (10) Human being, (11) Natural calamities—e.g., Flood, (12) Accidental calamities—e.g., fire.

Weather

Two main component of weather are temperature and humidity. If these two factors fluctuate rapidly, it can cause enough damages to the library collection. Even though it cannot be seen by naked eyes, all materials contract and expand with the fall and rise of temperature—causing growing weakness of the material which ultimately results in brittlness. Similarly rapid fluctuation of humidity can also cause serious damages. The best protective measure against this type of damage is to ensure the control of temperature and humidity to a fixed level within the library, which can be best achieved through air-conditioning. Proper air-conditioning not only ensure control of these two factors but it also helps in controlling problems caused by dirt, dust, environmental pollution, fungi etc. But in a developing country like ours, with limited financial resources, it is absurd to think about this solution. Only few big or specialised libraries can afford fully or partially air-conditioning and the rest, which covers the major section, should search for less expensive but effective systems.

Temperature

Maintaining zero degree temperature in library is an absurd proposal. Therefore, the temperature in the library should be maintained at certain level, however low that may be. The reaction of temperature i.e., how it effect the library collection is not visible in naked eyes, until some form of deterioration is occurred in it. e.g., excessive heat makes paper brittle, leather losses its natural oil and becomes rough and weak, durability of magnetic tapes both audio and video are gradually get lost. Mainly due to two reasons fluctuations of temperature strongly helps both chemical and physical deterioration ;

—firstly, physical properties of each and every material are effected by temperature ; secondly, most chemical reactions are effected by change of temperature.

Temperature i.e., heat is a type of energy, which can flow from one object to other and even within one object from one area to the other. This can happen in three different ways e. g., convection (when heat flows from one area to other through heated medium) : conduction (when heat flows carried by the particles of the medium) ; and radiation (when heat flows from more hot area to less hot one without direct influence of any medium). Whatever may be the mode of transformation of heat, it normally does not cause appreciable deterioration of any medium. Generally, the deteriorations which are noticed, are caused by some other one or more deteriorating factors acting jointly with heat. Those factors include moisture, sunrays, pollution etc. Increase of temperature makes the chemical reactions faster. It is normally said that the speed of reaction becomes double with rise of temperature by every 10°C. In case of cellulose, rise of temperature by every 5°C makes the speed of reaction double. Though it is now known to us that it is easier to preserve library materials at lower temperature, in practice, it is not feasible to keep library temperature to a appreciably low range. It is essential to have adequate precaution against too high temperature within library premises. Where it is not possible to have air-conditioning system installed, there should be some attempt to take help of other systems to solve this problem of excessive temperature e. g., keeping the shelves away from that side of the room, which is affected by direct sunlight. Attempts should also be made to see that no direct sunlight can enter the library by using either curtains or coloured glasses on windows or using special sunlight resisting sheets on window pans. It is better to make the library building plan in such a way that direct sunlight cannot enter any room.

Room temperature can also be controlled to a certain extent by making proper ventilation and also using electrical fans, whenever necessary. In case of very hot seasons, it should be ensured that hot air cannot enter the library. The ideal temperature to be maintained within the library is 22° to 23°C.

Humidity

Water present in air in form of vapour is the reason of humidity. The amount of water vapour present in each unit of air is known as absolute humidity. The relative humidity at a particular temperature is determined as follows—

$$\text{Relative humidity} = \frac{\text{amount of water vapour present at a particular temperature}}{\text{maximum amount of water vapour that can be persent at that temperature}}$$

Higher the temperature, the ability to hold water vapour by air, will be higher. The temperature and the humidity jointly makes the deterioraton of library materials faster.

In very low humidity paper, parchment, vellum, leather etc., becomes dry and brittle. Again, if it is too high, the atmosphere within the library becomes damp making boards swell, create a situation suitable for growth of fungi. The damages due to humidity may be caused in three ways : (1) growth and spread of fungi and bacteria ; (2) causing fading-of colour of the cloth used in library materials ; (3) reacting with the chemicals that are present in air, paper and other similar materials in library collection causing acidity and other damages or deteriorations. The deteriorating effect of humidity is dependent considerably on the temperature both atmospheric as well as of the materials effected. In case of higher humidity, the other damages that may occur, includes softening of the coating of the art or calendered papers, which may ultimately result in pages getting sticked to each other, which becomes very difficult and sometime impossible to separate. If the walls or floor gets excessively damped, it will be wise to keep paper etc., away from them. A close watch should be kept to prevent growth of fungi.

Control of humidity is the best way to face this problem. By air-conditioning system humidity can be kept between 50 to 55%. But in cases where air-conditioning is not possible humidity can be controlled by placing anhydrous calcium chloride, silica gel, activated alumina, activated bauxite etc., on saucers or shallow pans. Now a days, humidity can also be controlled by mechanical devices. Electric fans and air-circulators can be effctively used for controlling humidity to a great extent in rooms specially with dampy walls and fioors.

Light

Before we start discussion about light, let us say a few words about the sunlight. Among the factors that causes chemical as well as physical deterioration of library materials, the sun-rays occupies an important place. But fortunately very little sun-rays can enter the library premises or come in direct contact of the library materials. The sun-rays can effect coloured materials e.g., cloth or paper etc., by way of fading the colour. The sun-rays are accompanied by heat and that jointly effect paper, leather, parchment etc. and the result is almost same as that of heat—i.e., the materials become weak and brittle. The reflected sun-rays also effect the library materials adversely, but at a lesser degree. We have already told that the design of the library building preferably should be such, that no direct sun-light can enter the library. Adequate arrangements should be made to prevent entry of sunlight in the library by using curtain or coloured window panes (yellow or green) or by using sun-light resistant polyester foils.

One of the most important factors causing deterioration of library materials is light. Light means the full spectrum of light, which includes the visible lights that occupies the centre of the spectrum, on one side of which is the ultra-violet rays and on the other the infra-red rays. The wavelength of each section is different. Smaller the wavelength greater is the capacity of causing damage and therefore ultra-violet rays are more damaging than the infra-red rays. Fortunately, due to presence of ozone belt around the earth, most of the ultra-violet rays and lights with even shorter wavelengths are absorbed in that layer and they cannot reach the earth surface. Some amount of ultra-violet rays are also absorbed in the atmospheric air layer on the earth. The coloured glass panes can absorb 25% of the ultra-violet rays, and an appreciable portion of the infra-red rays.

Light is one form of energy, which can effect library materials chemically. To cause any type of damage the presence of one or more types of active energy is essential. This type of active energy varies for one medium to another. Light is one such active energy which can effect paper, leather, ink, cloth etc. in the library collection. As a result of photochemical effects coloured materials lose their colour and fade-out, dry up and become brittle. It happens in the following way—in presence of light, oxygen of the atmosphere reacts with the molecules of paper, leather etc. Once the reaction is started, it will not be stopped even if the material is removed from light and placed in complete darkness. Therefore, it should be always remembered that presence of light is essential for starting photo-chemical deterioration, though its presence is not always essential for its continuance.

The deteriorations caused by light cannot be noticed at the early stage. At that stage the paper etc., becomes slowly activated due to presence of light but this cannot be noticed as there is no apparent change on the medium. When the medium is fully activated then only the chemical reactions start. The time needed for starting chemical reaction depends on the nature of the material itself.

Whatever may be the deteriorating effect of the light on the library materials, it is neither practical nor possible to carry on library services in complete darkness and therefore, we have to accept certain amount of damages caused by light but all efforts should be made to keep this to a minimum possible limit. This can be achieved by controlling the nature, as well as the quantity of light and in case of necessity, by keeping the rare and weaker materials away from light. This becomes very important aspect to remember for avoiding deterioration of rare materials specially during exhibition of such collections of the library ; as it can be broadly said that :

Total exposure of light = Time × Quantity of light.

Within the library, there are mainly three sources of light—daylight (sunlight), flurocent tubelights and incandescent bulbs. Of these, we have discussed about the sunlight earlier. In case of incandescent bulbs tungsten coils are heated by electricity and as a result, light is produced. But the lion share of the electrical energy (about 94% in case of 100 watt bulb) is converted to heat and the rest to light. The presence of damaging ultra-violet rays in this incandescent light is negligible.

In case of tubelights, the mercury vapour within the tube is charged with electricity which produces ultra-violet rays. The walls of the tube, which is coated inside with phosphor, absorbs that rays and emits rays with a longer wavelength—the visible light. In case of this type of light, a control system known as choke is used. Though tubelight do not generate much heat, yet the choke emits some heat. The colour and amount of ultra-violet rays in the light is dependent on the nature of the phosphor inside the tube. In general the presence of ultra-violet rays in case of tubelight is comparatively higher than that of incandescent bulbs, but much less in compare to the daylight / sunlight. Therefore, if we arrange different types of lights depending on its damaging effects on library collections starting from most damaging to least damaging one, then the list will be direct sunlight—reflected sunlight—direct daylight—reflected daylight—cold white flurocent tubelight—white flurocent light—incandescent bulb. If the damaging power of direct sunlight is taken as 100 then damaging ability of different types of light can be indicated as given in the table in which damaging ability of filtered light is also indicated.

Damaging Ability of Various Types of Light

Types of light	Unfiltered	Filtered
Direct sunlight	100	8·5
Direct daylight (on a cloudy day)	31·7	5·1
Cold tubelight	11·5	3·1
Tubelight	9·2	1·8
Incandescent bulb	2·8	1·3

Though uninterrupted darkness is the best situation to prevent deterioration, but considering the practical situation we have to select between full darkness and extremely illuminated situation within the library, which is most suitable from practical as well as economical standpoint and this should be kept in mind while preparing the illumination plan of the library. The light (visible light) should be selected in such a manner, that it will be least damaging to the library collection. Light should be distributed all over the room evenly. In normal condition the light intensity within the library should be around 35 feet-candle.

Various gasoeus pollutant

During last few years, we are often listening about pollution on different perspectives and stages. But pollution is not a product of very recent origin, though currently it has increased manyfold and taken a very threatening situation. Since quite sometime, librarians and others who are connected with conservation problems become conscious and alarmed about this situation. Though the pollution problem is very old, yet its threat was comparatively negligible before the industrial revolution. Since then, through rapid industrialization it has increased extensively at almost unresistable speed to take the present threatening magnitude.

Generally atmospheric air contain (by volume) nitrogen (78%), oxygen (20.95%), argon (0.94%), carbon dioxide (0.03%). and various other gases e. g., neon, helium, methane, krypton, nitrous oxide, hydrogen, xenon, ozone etc. (0.08%). But in case of polluted air in addition to the above mentioned items the following materials are also present—carbon monoxide in gaseous state, nitric oxide, sulphur dioxide, olefin, aromatic hydrocarbon, aldehydes, parafins, hydrogen sulphide, halogen compounds etc., in a solid state or in dust form—dust, dirt, coal dust, ash, calcium sulphate, ammonium sulphate, and nitrate, chloride, few types of oxides, tar, charcoal black, spores of fungi, bacteria etc. All these are components of pollution. Even though these are present in air in very small quantity, their damaging effects are of appreciable range. It can be generally said that transports, productive industries, electrical power-stations specially thermal power-stations, garbages etc., are primarily responsible for pollution. The oldest source of pollution are wood, coal etc. which are used for cooking. Since thirteenth century, it was known that, if coal is not properly burnt, it gives rise to sulphur dioxide, carbon monoxide and several types of hydrocarbons.

The pollutants present in the atmosphere are in very small quantity—though it is comparatively slightly higher in case of city or industrial areas in relation to rural areas. From a statistics of 1965, we find that in United States of America the total weight of airborne pollutant is about 1250 lac tons .*

Some idea regarding this can be obtained from the table given below :

The Amount of Air Pollution in United States of America**

Pollutants	lac tons per year	%
Carbon monoxide	650	52
Oxides of sulphur	230	18
Hydrocarbons	150	12
Particles of various solid matters	120	10
Oxides of nitrogen	80	6
Other smokes, gases	20	2
	1250	100

One thing should be kept in mind that the situation in our country is much worse, in comparison to America. The main reason for this is that, there are various pollution control rules in force in America, which are mostly absent in our country and even very few such rules which are in practice here, are not properly followed or honoured.

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* Hanks, James J. and Kube, Harold D. Industry : action to control pullution. *Harvard Business Review* vol. 44, Sep-Oct 1966. p 49-62.

** Committee on Pollution. Waste management and control. Washington, National Academy of Science, 1966.

In 1930, there was a survey in 15 big cities of Europe and America from which it came to light that about 11 to 190 tons (1. 12 to 193.1 m. tons) of sulphuric acid is precipitating on the earth surface per square mile (2.59 sq. km.) area per year. In 1982 from another survey in Ankara, capital of Turkey, it was found that 520 mgs, of sulphuric acid and 141 mgs. of carbon monoxide gas is present in each squaremeter area. A similar report about Calcutta in recent time indicates that here the atmosphere carry about 400 tons of carbon monoxide, 122 tons of sulphur dioxide, 102 tons of hydrocarbons, 70 tons of nitrogen oxides per year.

One of the main effects of atmospheric pollution is the increase of acidity. From various statistics it becomes apparent that the atmosphere around us include enough elements which can, not only damage but also destroy the library materials by generating acidity in it. Now the pollution have reached such a stage, and increasing at such a great speed that the cultural heritage of human civilization is facing a serious threat. The white marble of Victoria Memorial Hall in Calcutta is turning yellowish, thin chips are coming out from the surface, and small cracks are developing. But this is not an isolated problem of Calcutta only—this is happening everywhere, all over the world—only difference is that in some places it is of moderate nature, in others creating a big threat. The famous Taj of Agra is also suffering from the same problem. This is the picture of stone structures ; but the situation is much more alarming in case of library collections and library materials, mainly due to the reason that they are mostly made up of either vegetable or animal products. This situation can only be faced by conscious and continuous efforts to conserve the collection by the librarians, the library staff as well as the users.

Source of Pollution in America*

Different sources	lac tons per year	%
Transport	748	59.9
Productive Industry	234	18.7
Power Industry	157	12.5
Various heating arrangements	78	6·3
Garbage disposals	33	2.6
	1250	100

The acidity causing effect of atmospheric pollution is the most important aspect on which we have to apply our attention first. Though at the fag end of the last century, we came to know about the effects of various gaseous pollution resulting in acidity, it took quite sometime to start active and conscious effort to prevent these evil.

Sulphur dioxide is present in the atmosphere of metropolitan and other big cities and industrial areas, which reacts with the oxygen of the atmosphere to form sulphur trioxide. This compound reacts with water vapour or humidity to form sulphuric acid. Nitrogen or nitrogenous compounds are not damaging to the library collection ; but nitrogen trioxide can react with oxygen and humidity to produce nitric acid. Nowadays polyvinyl chloride or PVC is extensively used for various purposes even in the library. Under the influence of heat and light, it can produce hydrogen chloride, which can easily reacts with the humidity in air to form hydrochloric acid. All these acids are capable of causing serious damages to paper, leather, cloth, plastics etc. These damages may be in the form of turning the white colour of the paper to yellow and making it weaker and brittle in in long run ; the ink markings may be faded ; red rot may start in leather objects.

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* Committee on Pollution. Waste management and control. Washington, National Academy of Sciences. 1966. (National Academy of Sciences Publication 1400).

Sulphur dioxide also damage the cellulose present in paper and cloth. In city atmosphere ozone gas is present in small quantity which can damage the organic materials, by breaking down carbons bonds. Damages caused by ozone is more common in hot weather in comparison to cold and temperate weather.

With the progress of civilization, use of coal, kerosene, liquid petroleum gas etc., are increasing day by day causing sharp rise in the air pollution. Fortunately, the situation within the library building is comparatively better than that prevailing outside, but still that much pollution is sufficient to cause enough deterioration of library collection. In many cases, the atmosphere within the library may be polluted due to reasons present within the library e.g., faulty electrical equipments causing sparks may generate ozone or old wooden furniture or frames of the room may generate organic gases, though its quantity is far below the level which is present in the atmosphere outside the library building. The deteriorating effect of these pollutants can work in two ways—firstly, through oxidizing and secondly, through causing acidity by formation of various acids.

Smoke : While burning wood, coal etc., the white, brown or blackish gas that comes out, is normally known as smoke, main component of which is carbon dioxide, but it also contain various other compounds. Smoke is always present in the air, whether it is visible or not. It becomes visible only when it is present in huge quantity or in a very crude form. If appreciable quantity of smoke remains in a small area for a considerable period of time, then it may initially cause light, but later dark black markings on the walls and other objects present in the area. Sulphur dioxide is another important ingredient of smoke, the damaging effect of which is discussed earlier.

Smog : In cities like Calcutta, Bombay and many other towns, particularly in winter season, we come across a special type of pollution which is generally known as smog. Actually it is the combined effect of fog, with that of smoke emitted by coal furnaces, used in day to day cooking in our country. The phenomena happens as smoke remain close to the ground level for a longer period due to presence of fog.

Salt : The cities which are situated close to the sea coast have small particles of salt or salty humidity in the atmosphere. The salt particles can be deposited on the library collection and ultimately reacting with the humidity of the atmosphere melts and damage paper, leather etc., and may cause small holes on the surface.

Carbon black : Presence of excessive carbon black in the air may cause dark markings on library materials ; paper and similar materials may be weakened and ultimately becomes brittle.

Ash : Presence of excessive ash in atmosphere may cause whitish marking on collection due to deposition, which ultimately causes chemical reactions damaging cloth, paper etc.

The best way to combat all these damages caused by pollution, is to make the library centrally air-conditioned as by this, it can be ensured that the air which enters the library premises are free from pollution and of all other things that may cause acidity. In those cases, where it is not possible to have central air-conditioning, every attempts should be made to resist the polluted air from entering the library building.

Sand, Dust, Dirt etc.

Particles of various solid materials float in air, collectively which are known as dust, dirt etc. These materials can be divided into two distinct groups—one, which can cause damages directly—these includes calcium sulphate, ammonium sulphate, nitrates, chlorides, several types of oxides etc. The damages caused by these are similar to that of polluted air. The second type of materials are those, that can not damage library collection directly—these include coal dust, wood dust, ash, sand etc. If these types of materials are present within the library in large quantity then the amount of damage caused due to other factors may go up appreciably. For example, if excessive dust is accumulated within the library, humidity can easily precipitate on it, generating a situation very favourable for growth of fungi. Often it is found that sand which is present in dust contain silicon particles. In case of strong wind or dust storm abrasive damages on the smooth surface of the library collection may be caused due to presence of silicon.

To save the library collection from the damaging effects of dust, dirt etc., regular and proper dusting is essential. It is possible to remove dust with the help of dry cloth duster, if used with proper care. But if the job is not done with proper care an appreciable part of dust may be moved to other places and get deposited there, without any good effect. In case of using vacuum cleaner, this type of problem do not appear, as all the dust are sucked and deposited in the bag kept for that purpose within the machine. Where dry duster can not remove all the dust, slightly wet duster can be used. In case of very dirty portion of rack, soap water or water mix with soda can be used to wet the duster for better effect. In case of certain delicate objects, hydrogen peroxide can be used. But before using water or chemicals, it should be ensured that these will not damage the materials in any way, on which these are applied. Air-conditioning is the best method to eradicate the problem caused by these, as in that case the possibility of dust etc., entering the library will be almost nil. In absence of air-conditioning, efforts should be made to prevent dust entering the library by fixing fine nets in the windows or fitting curtains on doors and windows.

Fungi, Viruses, Bacteria etc.

Spores of fungi are always present in air and these can easily enter the library in airborne condition. Fungi may be of various types, only a fraction of which are damaging to the library collections. The fungi which may create problems in library are not of the parasitic type. The damages that are caused by them are considered as biological damage. In a favourable condition fungi can grow and spread on paper, cloth, leather etc. Hot and humid atmosphere is most suitable for their growth. They can exist even in full darkness ; but in direct sunlight or bright artificial light (specially which contain appreciable quantity of ultra-violet rays in it) its growth becomes retarded and they are destroyed if exposed to this condition for considerable period. A temperature of 15° to 30°C and humidity of 80 to 100% is most suitable for their fast growth. In an adverse situation it can remain in a dormant stage even for a period of twentifive years.

Fungi need very small quantity of iron, copper, manganese etc. other than carbon, hydrogen, sulphur, potassium, magnesium, phosphorus etc., for its nutrition and growth. Some fungi also depend on cellulose available in library materials for their nutrition. It can attack and damage some type of leather, adhesives used in binding etc.

The best solution, for preventing this type of damages, is to go for air-conditioning, if possible ; as both humidity and temperature can be kept under control within certain range by this system. In addition to this, the entry of spores within the library building should be prevented. In cases where fungi has already started thriving, good effect can be achieved by spraying 10% solution of thymol in methylated spirit. First, the books which are effected, should be properly cleaned with the help of soft cloth or cotton and then they should be treated with some type of fungicide. If the number of books effected are large, then arrangements should be made for thymol fumigation. It is essential to keep the internal environment of the library clean to control and eradicate fungi problem.

Few types of airborne viruses and bacteria can attack the iron compound present in the paper resulting in appearance of brown patches on the surface, which are known as 'foxing'. On examination it will be found that acidity on those areas have increased. The best way to prevent these problems is to ensure that the air within the library premises is clean and free from all impurities and pollutions.

Insects

Generally in a hot climate, if the librarian and library staff are not very much conscious about the cleanliness of the internal atmosphere of the library, it can ultimately result in insect attacks in one or more areas. There can be various types of damages and deteriorations in the library due to such attacks. The list given below will indicate the types of damages that can be caused by different insects.

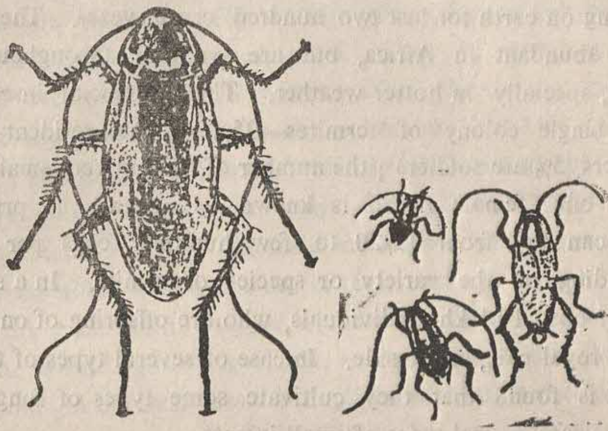
Insects	Effected materials	Type of damages
Cockroaches	paper, board, binding materials, cloth, parchment, leather etc.	can eaten off ; dark blackish markings appear on the surface
Termites	paper, board, cloth, wood etc.	can eat up the materials
Firebrates, Fishmoths, Moths, Bristletails, Silverfish, Slickers	adhesives, binding materials, photographs, surface layers of paper, photographs etc., paper and other materials containing starch.	can eat up materials —partially or fully

Insects	Effected materials	Type of damages
Bookworms	paper, board, adhesive, binding materials, cloth, covers etc.	damages by making narrow tunnels in the materials.
Booklice	fungi that grow on adhesive used in binding and on other starchy materials.	can eat up the fungi grown on the materials
Warps	cloth, leather etc. used in binding ; paper etc.	make nests on the materials with help of their saliva. At the time of removing them materials are damaged.
Moths (in larva stage)	cloth, leather, paper, adhesives, and other binding materials	can eat up the materials

Cockroaches

Cockroach is a very common type of insect, which is known to us all. Broadly, cockroaches can be divided in eight groups e. g. , German (small tan coloured). Australian, American, Surinamian, Oriental (black), one with smoky brown body, other brown-banded body and another wood dwelling group. In our country, we come across mainly two types of cockroaches—one group is of smaller size of about 1.3 to 2.5 cm (½ to 1 inch) in length—german type (Blattella germanica) and the other group, the American (Periplaneta americana) about 3.7 to 5 cm. (1.5 to 2 inches) in length. Cockroaches generally prefer to live in dark areas. They become active in darkness or at night. They can lay 14 to 30 eggs at a time (the number varies from group to group). The eggs remain within bean-like capsules. Normally, within 35 to 45 days small cockroaches come out of the eggs and attain adulthood within 6 to 10 months. Smaller cockroaches can live 5 to 6 months, whereas the larger ones can survive upto 2.5 years.

Two Most Common Types of Cockroaches



American German

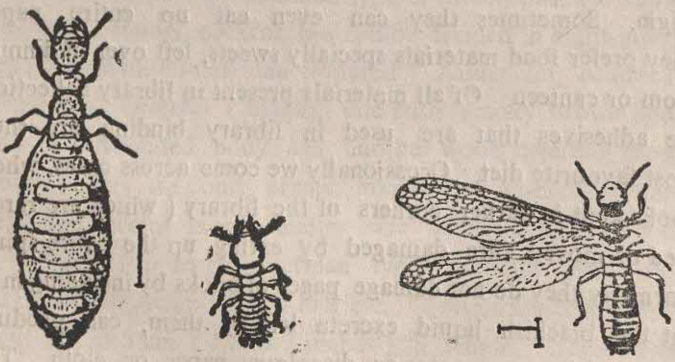
Cockroaches can damage and even destroy book covers, cloth, board, paper, adhesive, gelatine and materials of starch origin. Sometimes they can even eat up entire paper. They prefer food materials specially sweets, left over in dinning room or canteen. Of all materials present in library collection, the adhesives that are used in library binding are their most favourite diet. Occasionally we come across cases, where books kept in darker corners of the library (which are rarely used or moved) are damaged by eating up the entire spine. Normally they do not damage pages of books by intruding in it, but the blackish liquid excreta left by them, can produce ugly markings on pages or discolour paper or cloth. The damaging effects caused by cockroaches are much more common in comparatively hot and dirty environments, where materials remain in same position for long period, than in ease of colder and cleaner surroundings.

Termites

Out of all damaging insects which can affect library materials in one way or the other, the termites are the most damaging and dangerous. Termites are very old insect who are residing on earth for last two hundred crore years. They are most abundant in Africa, but are available throughout the world, specially in hotter weather. They are social insects—in a single colony of termites—95% of the residents are workers, 5% are soldiers ; the number of male is very small and only one female (who is known as queen) is present, who can lay from 15/20 to few hundred eggs per day, depending on the variety or species of termite. In a single colony upto 10 lakhs individuals, who are offspring of one and single royal pair, can reside. In case of several types of termites, it is found that they cultivate some types of fungi and domesticate several types of small insects.

Different Type of Adult Termites

(magnified five times)



Queen Worker Male

There are three stages in the life of termites—egg, intermediate and the adult ; adults can be of four types—workers, soldiers, males and female i.e., queen. Neither soldiers nor worker develop wings. They cannot reproduce too. Both male and female develop wings and once in a year (either at the beginning or at the end of rainy season) they come out of their nests and fly out to select suitable spots to stay and start a new colony. The physical appearance of both male and female are slightly different from that of small soft bodied, wingless blind soldiers or workers. They are slightly darker, slender bodied with brittle wings. When the suitable spot for new colony is selected, the male and female (the king and the queen) get rid of their wings, which breaks down at the point where it is joined with the body. Thereafter the body of the female starts to grow. The male and female termites can bear light only when they come out of their nest and have wings—other than that period they, as well as the soldiers and workers can not stand light. Previously it was thought that they do not come out of their nest in daylight or in lighted condition mainly because they can not bear light ; but recent experiments confirms that the main reason behind such behaviours is the controlled humidity within the colony/nest, which is extremely essential condition for their survival.

It will be a better proposition to try to find out which are the materials not eaten up by termites, as it will give us a much shorter list than the list of their foods. Grass, dry leaf, straw, wood, paper, board, leather etc., almost everything is included in their long list of food. If they can properly intrude in a library, then within a short period, they can produce irreparable damage. Therefore it is wise to have a regular watch, if not daily, in all possible corners where attack may start. Special care should be taken for those corners, where materials remain in undisturbed condition for considerable period. Wooden shelves, old dampen walls are more susceptible areas, where attack may start. Normally attacks start so silently and without any external indications, that in most cases it escape our notice, till it have taken an alarming shape and by that time, lot of damages are already caused.

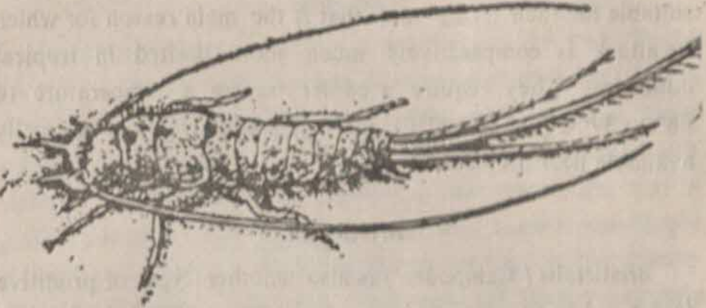
Termites are broadly divided in two groups—those who build their nests in ground and those who lives in wood ; of the two groups—the first one is more dangerous and far more damaging. They build their nest in ground or through narrow tunnels keep contact with the ground. Once attack is started in full strength wood, paper, cloth etc., and all other cellulose containing materials are eaten up and transformed into termite mould. 95% of the total damages caused by termites are done by these ground dwelling group.

The wood dwelling termites are normally found in the cracks of building or wooden frames through which they enter the building. Their food and power to damage library materials is similar to that of other variety of termites, only difference is that they act comparatively slowly.

Silverfish

Silverfish (Lepisma saccharina), Firebrats (Themobia domestica), Fishmoth, Slickers—all of them belong to order Thysanura, which include about 700 species. This is one of the most primitive orders. All the members of this order are wingless, nocturnal ; and among more primitive members of this order eyes are absent altogether.

Silverfishes are wingless, nocturnal insects of 2.5 to 3.7 cm. (1 to 1.5 inches) in length. Their soft bodies are covered with grayish brown or silverish ash coloured scale which give it a shiny silvery appearance. There are two long antennae on the head and three similar appendages at the tail end, each nearly as long as the body. In case of several types of silverfish, presence of tiny eyes are noticed. They feed on a large variety of materials e.g., the sizing materials of paper, starched clothes, rayon fabrics, any paper on which glue or paste is used, binding materials—in one word we can say—anything that contain starch, carbohydrate and protein. They eat up the coating on art-board, art-paper, photographs etc. On



(Magnified four times)

the darker corners of the shelves, backside of the drawers, below the papers which remains undisturbed for long period and where the condition is damp and dark—they lay tiny eggs, from which offsprings are born within two weeks in summer and four weeks in winter seasons. The young ones are exactly similar to that of adults, only they are of smaller in size. They attend adulthood within six months. They can damage materials during daytime also, if the area remain dark, though they are more active at night. From the standpoint of damage done to library materials, their name comes only next to termites. One interesting information about silverfish is that, they can live several months without any food.

Firebrats

Firebrats are very much similar to that of silverfish—only the colour is slightly darker and blackish. They are also nocturnal, but they prefer comparatively warmer climate. They generally live in that corner or side of the room, which is warmer but dark. As regards to food habits they are very close to silverfish i e., they prefer gelatin, paste etc,. which contain high amount of protein, carbohydrate and starchy materials. Fortunately in warmer countries like ours, where fireplace is not used, they rarely found a corner having enough warmth suitable for their living and that is the main reason for which its attack is comparatively much more limited in tropical countries. They require a corner having a temperature of 38° to 39°.C (98° to 102°F) for laying eggs which is normally available near fireplace.

Bristletails

Bristletails (Campodea) is also another type of primitive insect and in appearance is very much similar to that of silverfish. They do not have eyes. They belong to order Diplura (but some entomologists include this insect under order Thysanura). The main difference between these two orders are that in case of Diplura the mouth is situated within a fold, which is not noticed in other orders.

(Magnified three times)

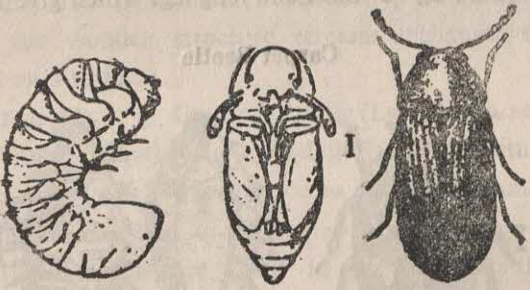
Bristletails are also nocturnal. They have a wingless soft body of about 2.5cm (1 inch) length. There are two long antennae on the head and similar two appendages at the tail end. They prefer dark and damp corners for staying. They consume paste, glue, gelatin starchy materials as food and thereby damage paper, cloth, thread, adhesives etc.

Fishmoth, Slickers etc., are also very much similar to silverfish ; they are nocturnal and prefers dark, damp corners and damage books, papers, cloth etc., present in library collection.

Bookworm

No special type of insect is identified by the term 'Bookworm'. Some two lakh seventy-five thousand different types of beetles are found in various parts of the world of which larvae of some two hundred species are popularly known as bookworms. It should be remembered in this connection that in adult state these insects do not cause any harm to the library collections. Most of the bookworms belong to the Family Ptinidae of order Coleopetra. This type of beetles normally lay eggs in and around the cover of books. The larvae after coming out of the eggs, start digging tunnels in the paper of the book, boards, cloth etc., of the cover for their own nourishment. In severe cases the number of tunnels are so high and the pages are so much damaged that the writing or printing on it becomes almost impossible for decipher. On the wall of such tunnels there is a coating of dried saliva like materials

Drug-store Beetle



Larva Pupa Adult

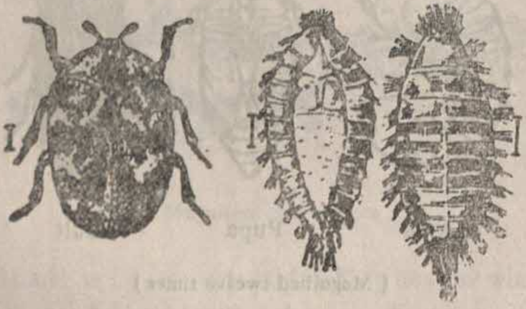
(Magnified twelve times)

(which is actually a form of secretion from their bodywall) which makes the pages get entangled to each other. If attempts are made to separate the leaves from one another with application of force, the pages get seriously damaged, as they are already very weak due to the presence of numerous tunnels. All bookworms are not equally damaging to paper, books and other library materials. Drug-store beetles (Stegobium paniceum) is one of the most damaging type of bookworm. One female drug-store beetle can lay tiny white (1·5mm or $\frac{1}{16}$ inch) 100 eggs at a time, which hatch in 6 to 10 days during summer giving rise to yellowish white larvae.

On hatching the young larvae immediately attack such food materials which are available in their surroundings e.g., paper, board, cloth, adhesive etc. Within 30 to 40 days they reach their adulthood of which 8 to 10 days are passed in the pupal stage. The full life circle (from egg to end of adult life) takes 60 to 75 days.

Another type of beetle having roundish small body with tiny eyes and two long antennae and long legs which give it a spider like appearance is commonly known as spider beetle or Ptionus fur. They cause severe damage to the board, paper, cloth etc.

Carpet Beetle



Adult Pupa Larva

(Magnified seven times

Another beetle known as Larder beetle (Darmestes lardarius) have small (about 1 cm or $\frac{1}{3}$ inch in length) brownish body with yellowish markings. They damage library materials of animal origin e. g., parchment, leather etc. more, in comparison to other materials e.g., paper, board etc. They lay eggs on the binding which on hatching give rise to larvae who destroy the leather of the binding by eating it up and grow in size considerably. Normally on attaining adulthood, they leave the library building.

Serious damages to wooden furniture, palm-leave manuscript, wooden-book etc., are caused by powder-post beetle (Anobium panctatum and Lyctus brunneus) and Deathwatch beetle (Xestobium rufovillosum) etc. Their damaging capacity is only next to termites. They lay their eggs in narrow pores of the wood. On hatching the larvae start eating wood etc., and dig out tunnels which are found to contain flour like powders in them, which is the indication of their presence. Though they damage wood etc. internally, the outward appearance of the wooden structure remains unchanged till it collapse, all on a sudden.

Other beetles e. g., Cigarette beetle (Lasioderma serricorne), Carpet beetle (Anthrenus scrophulariae). Furniture beetle (Anthrenus flavipes, Attagenus piccus) etc., also damage library materials like leather, cloth etc., used in binding.

All these beetles are small in size and enters the library through open window or door and lay their eggs within the library building.

Booklice

Occasionally while opening a long unused book kept in dark damp area, one can notice very tiny yellowish white insects fleeing away—these are booklice (Liposcelis divinatorius or Atropos pulsatoria). They belong to order Corrodentia. They have a soft wingless body with comparatively big head portion with mouth suitable for chewing and small compound eyes. Their antennae are as long as the body and they have long legs. Though they live inside paper, books etc., they

(Magnified eighteen times)

do not eat gelatin, cellulose or adhesive present in these materials. Their main food is fungi (in some cases it is found that some species also damage the coating on paper).

Though they do not create major damage to library collection, they indicate possibility of severe damages in near future caused by excessive damp conditions, unless proper precautions are taken in this aspect.

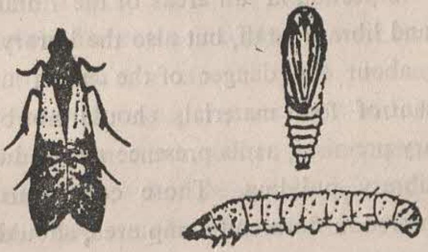
Wasps

Wasps do not cause any direct damage to the library collections, but there are 35 to 40 species who build their nests to lay their eggs by mixing saliva with mud within the library building. When dried this mud mixed with saliva becomes as hard as cement. In many cases they build such nests on the corner of shelves or on the books. While cleaning these, the books etc., can get damaged. These wasps belong to order Hymenoptera and Family Eumenidae. Of these Eumenes fraternal is most important one.

Moth

Moths belong to order Lepidoptera. Out of the huge family of moths only a small section is found in library, whose larvae damage binding materials e. g., cloth, leather etc. Most of these damaging moths belongs to Tineidae family. It is very interesting to note that at the adult stage moths are very innocent and do not cause any damage, as at that stage they do not eat anything. They normally lay their eggs in such places (on cloth or leather used in binding), where immediately after hatching, young ones can get enough food in their vicinity. Each female moth can lay 100 to 150 eggs on cracks of walls, shelves or on folds of the spine or on bound spine etc. How long they will remain in the larval stage depends entirely on the quantum of food supply available to them, but normally it is between 6 to 8 weeks. But in case of inadequate food supply this period may spread upto 4 years. Other than food supply, the span of larval stage is dependent on the moisture of the atmosphere. In normal room temperature and 75% relative humidity their life span becomes minimum. During the larval stage when their body remains hairless with blackish head, they eat up cloth, leather etc. used in binding. It is worthwhile to mention here that moths do not normally damage goat skin. The reasons behind this phenomenon is not known. They spend a period of 1 to 4 weeks in the pupal

Cloth Moth



Adult Pupa (above) Larva (below)

(Magnified two and half times)

stage and then another 1 to 2 weeks in the adult stage. Though available almost all over the world, they are more abundant in tropical areas. Most important among them are the Carpet moth (Trichophaga tapetzella), Cloth moth (Tinea pellionella and Tineola bisselliella).

Steps to Protect Library Collection from Insect Attack

The following three steps, if taken properly, will help to reduce the possibility of insect attack in library considerably. The steps are—(1) to keep the environment both in and around the library building clean and tidy ; (2) always remain alert about any possibility of insect attack ; (3) to maintain regular and adequate inspection in all areas of the library. Not only the librarian and library staff, but also the library users should be conscious about the danger of the insect attack. Food packets, remnant of food materials should not be allowed to enter the library premises, as its presence may induce the insects to enter the library building. Those collections which have spent a long period in dark and damp area, should be carefully examined before that can be placed alongwith other collections. Before adding any new collection of old and rare materials, that should be first properly disinfected. If necessary fumigation can be done to obtain the best result. By utilising the air-conditioning system, good result can be obtained as in this system the windows, doors etc. remain closed making the possibility of insect enering the library building to a bare minimum. It also make the environment most unsuitable for many insects to live in.

In ancient India, manuscripts etc. were preserved by wrapping them in a special type of red or yellow cloth. But current tests in laboratories have proved that these colours do not have any insect repellent property. But in those period, various herbals were used to dye the cloth, which may induce its insect repellent properties.

Previously in our country books, papers etc., were left in direct sun to get rid of both insect larvae and eggs. But direct sunlight have serious damaging effect on library materials (79 p) and so this practice should be avoided.

Various chemicals can be used to control and prevent insects e.g., naphthalene, odonil, paradichlorobenzene, camphor, birch root dust or oil, creosote oil, clove oil etc. In general, spraying of Finit, Begon, Pip at regular intervals (as its effectiveness lasts only for few days) fairly good result can be obtained. These steps are meant for general insect control. But there are some specialised control methods for specific type of insects. Let us now look into those systems briefly.

For silverfish, firebrats and similar other insects a mixture of flour with boric acid or a mixture of 16 parts sodium fluoride, 10 parts powdered sugar, 5 parts salt with 200 parts flour, can be spread on the areas, where these insects are generally found to move about. But the second mixture should be used with adequate care as sodium fluoride is a very strong poison. This type of application also effects the neatness of the library premises. The effective alternative of these method is to keep small quantity of flour (1 teaspoonful) in a specially designed covered glass container at small gaps (at a distance of about 1 metre i.e., 3 to 4 feet) within the effected area, so that silverfishes and similar other insects will be able to enter the container to eat flour but can not come out of the same. Apart from this, adequate spraying of 5% DDT or 2·5% chlordane or 1% lindane or 0·5% dieldrin or 1% pyrethrins will give good results.

The above mentioned insecticides are also very effective in case of controlling bookworm, booklice etc. Apart from these sodium fluoride, white arsenic etc., can also be used, with adequate care, as all these are strong poison. White arsenic should be used with few drops of water to bind the powders together. It will be best to keep these in small top open, cardboard boxes, which help to keep the inner environment of the library clean and tidy. The books which are already effected by insect attack should be segregated so that, they can be fumigated properly in due course.

For cockroach problem, in addition to spray of insecticides, Baygon Bait which is prepared from isopropoxy—phenyl methyl carbonate can be used. It is more effective in case of bigger varieties (american). The smaller varieties (german) are normally resistant to general insecticides and therefore those are not very effective in controlling them. In such cases 1% to 5% malathion or 0.5% diazinon or 1% dicapthon can be sprayed with very good result. Spray should be done adequately, specially in dark and damp areas in the library, where the cockroaches are found. 10 part of boric acid mixed with 90 parts of sugar will give a good bait which have a proven effectiveness against german cockroach.

To effectively control termite, precautionary measures should be taken from the very first step of construction of library building i.e., immediately after the site is selected, the soil should be specially treated with specialised chemicals e. g., 1) 0.5% aldrin or dieldrin ; 2) 0.8 % lindane ; 3) 1% chlordane. These chemicals mixed with oil or water can be sprayed properly in the soil. Excepting these, 4) 8 % DDT or 5) 25 % trichlorobenzene or 6) 5% penta-chlorophenol mixed with oil will give very good result, if properly applied. 7) 10% sodium arsenite mixed with water can also be applied. One thing should be remembered., that if possible, chemicals mixed with water should be used in preference to oil mixture, which is inflammable and may create fire hazard. Nowadays several new chemicals are preferred for using, due to the fact that these help to eliminate the offensive odour and similar other problems. During the construction of the building care should be taken so that wooden frames do not come in contact to the ground. At the time of painting wooden frames, some chemicals e. g., Termex etc., should be mixed with the paint to prevent possibility of termite attack. It is always preferred to use steel furniture and steel racks, but in case of using wooden shelves all possible cares should be taken to see that the bottom do not touch the ground/floor, if necessary, arrangements should be made to dip the legs of the rack etc., in kerosine oil mixed with water kept in small bowls. Those portion of furniture or wooden frames, which are close to ground level should be coated with tar mixed with creosote or any of the following chemicals—zinc chloride, mercuric chloride, sodium fluorosilicate etc., in solution form to adequately soak the wood ; or after application of the chemicals the wood may be properly heated, so that chemicals can penetrate deep in the wood. If the building have past record of termite problems, it will be wise to use steel furniture instead of wooden ones. In case of termite attack, the books which are not fully damaged and can be restored should be separated, cleaned and fumigated in due course and only after that, they will be placed in stack area alongwith other collections.

In preventing attack of powder-post beetle methyl bromide fumigation is most effective. Apart from this 1) 5% DDT or or 2% chlordane or 0.5% lindane mixed with kerosine oil ; 2) 5% pentachlorophenol mixed in oil ; 3) 10 parts borax mixed with 100 parts water and 125 gms sodium lauryl sulphate can be applied with very effective results.

To prevent the attack of bookworms or the larvae of beetles, fumigation is the most effective system. Generally 5% DDT or 2% pyrethrine mixed with kerosine can also be applied with good result. Adult inscets can be destroyed by using modern equipments, in which light is used to attract and trap them. To use this type of light traps, all other sources of lights should be put off, to get most effective results.

To prevent attack of moth, the same measures that are used in case of bookworms, can be utilised effectively.

Animals of Rodent Group

Out of the rodent group which include rat, squirrels, beavers etc., rat and mice are most common. They are occasionally found to make their holes inside the library building and may cause considerable damages to the library collection. They feed on paper, cloth, leather, board etc., — almost everything that is available in library. Dirty environment, availability of cracks or holes on the wall/floor or any other dark and suitable place, where they can hide, induce rodent attack. But if we are able to create an environment where these are absent, the possibility of rodent attack will be eliminated. Presence of food packet or food residue within library is another important reason for rodent problems.

Once presence of rodent in the library is noticed, various traps can be used to catch them. But soon it will be noticed that they are avoiding the traps. They become cautious about the baits. By changing the baits and also the location of the traps and alternatively using different type of traps, may solve the problem to a large extent. Meat, fish, food materials with odour of coconut oil can be very effective bait. They cannot stand the pungent smell of naphthalene, paradichlorobenzene, camphor etc. Apart from these, if caustic soda is spread on places of their regular visit, a type of skin disease is induced on their feet and ultimately to their mouth (as they want to reduce their uneasiness by licking the feet) which make them afraid and flee from library premises. But before restoring to this method, it should be remembered that this will create cleanliness problem within the library and caustic soda have damaging effect on human skin also.

Various poisonous chemicals e.g., arsenic trioxide, barium carbonate, phosphorus, zinc phosphide, mercuric chloride, sodium fluoride etc., are used to kill rodents. All these are very strong poison and therefore. adequate care should be taken during their use. Discussion will be made regarding these poisons and their effects on human being at a later chapter.

Man

Though it may sound strange, it can be said without slightest doubt that one of the most important enemy of the library collection is man himself. While discussing about human enemies the first name that comes up, is that of librarian, then library staff and finally the library users and others.

The primary duties of librarian include assurance of adequate conservation of library collection and its proper use. Depending on physical conditions of the library collection it should be decided which are to be withdrawn from the general use and kept separated for special use by scholars and researchers or treated as extremely rare and kept away from any use of the original (only copy, of such materials xerox or otherwise —can be used for research and other purposes). But before imposing such restrictive measure, it should be properly ascertained that these steps are absolutely essential. Any restriction on use of even a small part of the library collection, if not absolutely essential for some reason or other, is against the basic library ethics. Considering carefully the importance and necessity of each and every request for using the library materials

(specially rare and delicate ones) decision should be taken, whether the permission can be given or not, so that neither the library ethics nor the conservation ethics is adversely effected.

It is a social responsibility to increase as well as to protect the library collection—though the primarily responsibility of such job lies with the librarian and library staff,—as a representative of the future generation—the present users also have major responsibilities. One of the five laws of library science as propounded by Prof. S. R. Ranganathan is "Books are for use". (The book which do not have any users will find its place temporarily to some godown or similar place and then to yet some other place for some other purpose). Therefore books or documents will be used repeatedly and that will effect its physical conditions—e. g., binding may be loosened, leaves may come out, paper may be weakened etc. The librarian and the library staff should have special attention on these aspects.

In this aspect though the library users have responsibilities ; the library workers have also special role to convince and make the users understand the avoidable damages that are caused by their careless handling of library materials. The mistakes normally done are : 1) folding the corner of the page (to mark the page upto which reading/consultation is done) ; 2) closing the book after keeping a pencil or pen or any other similar material within the book (to mark the page or to facilitate to find a particular page quickly) ; 3) to keep open book on reverse position (i.e., with spine upward and pages facing the surface of the table) ; 4) taking out book from the shelves by pulling the spine (this may damage both the binding and the spine) ; (5) to make pencil or ink marking or writing notes on margin of pages ; (6) turning the pages without necessary care (the pages of a book should be turned from the top with care, in absence of which it may be weakend or damaged) ; (7) reading a book while lying on bed or in an inclined position (in such cases the book is supported by one hand only and if that is thick one, the spine is subjected to serious strain, which may cause major damages) etc.

Apart from these, some users are found to make much more serious damages to the collection through mutilation, theft etc. Morally these users are very inferior. But commonly it is not very easy to identify them, so the library staff should keep their eyes and ears open and remain very vigilant. So-long education and social consciousness among the public do not reach saturity, the library collection will be damaged, if the vigilance is not up to the mark or there is any slackness on the part of library staff. In upper class societies abroad the cases of book theft is viewed in slightly separate angle than ours. They consider it as a sign of serious selfish attitude of booklover. There attempts to retrive the lost books or rectifying the habit of doing these type of mischief, is gradually reducing. Jokingly it is said that some responsible booklover have taken the job of preserving and protecting the lost book.

To prevent book theft and book damage a very alert vigilance is essential. In case of detection of any such case, concerned reader should be debarred from using library facilities and a strong attitude should be taken on the matter.

Natural Calamities

Flood : Among natural calamities flood is the most damaging to libraries. Most of the libraries in our country have the possibilities ,to be effected by water logging either due to excessive rain or flood which is a very common occurrence (almost in every alternative years) in certain areas of our sub-continent. Apart from excessive rain, carelessness of library staff or due to fault in some mechanical system e. g., bursting of pipe, clogging of water drainage system may result in water logging.

Care should be taken so that water logging cannot happen—

not only within the library but also in the neighbourhood of the library building, as that may result in dampy atmosphere in the library, which is very harmful from the conservation standpoint. If the locality is flood-prone or possibility of water logging in the area is fairly high—then it will be better not to keep any book in the ground floor (if at all possible considering the economic condition of the libraries—as most of the library building in our country are single storied). But where it is not feasible, the shelves should be placed in such a position that it remains above the possible water line and the bottom shelves should be left empty as an extra precautionary measure.

With the help of advanced technology it is possible in western countries to have a warning system, through which the librarian as well as the head of security department of the library, is alerted about the danger of flood or water logging before it actually happened so that they can take some necessary measures within the short time, that is available at their disposal. It is almost impossible for libraries in our country to take help of these advance technologies, due to its high cost and financial condition of our libraries. Therefore, we have to depend on general alertness e. g., if any pipe carrying water passes through a part of a room, then as a precautionary measure book-shelves should be placed away from that area, otherwise in case of any accidental oozing of water may damage books/documents.

Library collection can be saved from water damage by conscious planning and adequate alertness. But to protect collections from sudden natural calamity (flood etc.) along with all the preventive measures certain amount of luck is also essential. In case of any such accident, the first and foremost duty of the librarian and library staff will be to segregate the rare and important collections, which are not replaceable and try to protect them as far as possible.

To face a fairly big flood or water logging problem the necessary measures to be taken are :

(1) To stop further deterioration in the effected area ;

(2) All possible steps to stabilise the situation. Temperature and humidity should be reduced as far as possible ; shorter the time taken to achieve it, is better for the library building and the library collection. A temperature of 21°C and relative humidity of 70% helps fungi attack and its fast spreading. Normally fungi start growing on wet materials after two days or 48 hours.

(3) All materials necessary for rescue operation should be collected as early as poosssble ;

(4) All workers connected with the rescue work should be informed, gathered around the place of operation quickly ;

(5) Water damaged books and documents should be removed from the effected areas—(a) moisted materials (books, documents etc.) should be removed by relay system ; (b) effected materials should be kept in a safe area, not much away from the place of occurrence ; (c) materials which are more moisted should be removed on priority basis ; (d) the moist materials should be kept in separate groups on the basis of amount of damage that have already occurred (if possible in top open plastic trays—similar to that which are used by Mother Dairy for transporting milk packets). Each tray should be leveled indicating condition of the content (e.g., slightly, moderately or seriously damaged etc.) (e) damaged materials should be removed to appropriate departments ; (f) if possible vacuum drying system should be used ; after drying, proper fumigation should be done ;

(6) Moist photographs and similar matertals should be kept in wet condition and then transported by refrigerated car to the laboratory, where these will be restored in due course ;

(7) Those materials that will be dried in air, are to be separated and shifted for drying. Coated paper or art papers

can not be dried in air, as in that case adjacent pages may get entangled to each other ; which is known as blocking ;—(a) if it is found that waters flow, temperature/moisture etc., can not be be controlled—the damaged materials should be removed to a fixed area to dry them in air ; (b) on long tables fresh newsprint should be spread and on that moist materials will be placed. Arrangement of electric fans and moisture control should done ; (c) book trollies can be used for transportation of materials ; (d) moist books should be kept in standing position with covers remaining slightly apart. Fans should not be operated in full speed, as high breeze may turn the pages and will damage them. Books should be supported from sides with some supports, so that, the pages do not hang out damaging the spine or effecting the shape of book to deteriorate ; (e) When almost dried, books will be allowed to stand in closed condition on covers with support from both side. Paper-covered bricks can be used as support ; (f) When fully dried arrangement should be made for fumigation ;

(8) Effected area should be thoroughly cleaned and disinfected with fungicides and insecticides ;

(9) After drying and fumigation ; restoration, binding etc. should be completed ;

(10) Those documents which are subjected to vacuum drying are to be kept separated for six months so that it can absorb moisture from atmosphere slowly to return to normal condition. After that period, is over these materials should be restored and rebound.

Accidental Calamities

Fire : In general it is found that the number of occurrence, as well as amount of damage done by fire is quite low in case of library, in comparison to others institutions.

Fire can do more damage to library and its collections than it can do to other institutions. The most important aspects of fire damages are : (1) It happens all on a sudden, without any warning for preparation ; (2) Fire can damage almost everything that is found in library collection ; (3) If it starts in some remote corner, at the initial stage, it may not be noticed by library staff, until it spread considerably ; (4) The material which is most used for extinguishing fire is water, which is used by spraying at a high speed with help of hose and that may cause considerable damage to different library materials e.g., paper, books, etc. in form of fading colour of cloth, swelling of leather, pages can be entangled to each other, papers may be weakened etc. ; (5) In case of big fires, entering inside library building for rescue operation cannot be undertaken until fire come under sufficient control.

The heat generated by fire destroys the natural moisture of paper and starts decay. The steps which are essential for protection against fire damages are—

(1) At the time of planning library building adequate importance should be given to fire prevention system ;

(2) Location of departments should be made keeping in mind the possibility of fire problems ;

(3) The fire detection system should be carefully installed and kept in operational condition, as slight fault in it may result in major damages ;

(4) The last but not least important is to have adequate arrangement for fire fighting.

If adequate care is taken at the planning stage of the library building, the chance of occurrence of fire hazard can be kept to a bare minimum and even in case of incidence of fire, it cannot spread in larger areas and remain localised.

Steps to be taken at the planning stage of library building to prevent fire problems

It will be ideal if fire resistant materials can be used for library building ; though that do not ensure that there will not be any problem caused by fire in the library. In such cases, it may so happen that due fire all the library collection are destroyed, where as the library building remained almost unaffected. Therefore, at the time of construction along with making it fire resistant, it should be so planned that it become convenient for fire fighting. If it is possible to deposited a copy of the 'building plan of the library' to the nearest Fire brigade office, that will be another positive step to fire fighting (this policy is followed in case of most big libraries abroad). The building plan must indicate the location of main stack, staircase, entrance/exit. rare collection room, what are the more inflammable stock and where they are located, location of catalogue and other important documents etc. The possibility of fire accident remains equal both during day and night and therefore a detail building cum location plan if not available handy with the fire brigade office, it may become extremely difficult for them to act quickly, specially in case the fire starts at a time when library remains close and staff are away.

Though attempts should always be made to protect the library collection in tact, but it should never be at the cost of the life of library staff or users. Therefore, there should be provision of adequate emergency exits.

For effective fire-fighting, library should be divided into smaller sections. In earlier days, the stacks were located one above another, which increases the possibility of quick spreading of fire. In modern system the stacks are spread in different areas so that it takes considerable time for fire to spread from one stack to the other. If the staircase, lift, pipes etc., are kept in enclosed form, fire cannot spread through these areas. The working space should be away from the stack area, as generally it is found that in most cases fire starts from the working area, due to carelessness. The fire fighting arrangements should be strongest in the stack areas.

The air-conditioning machines. electrical equipments should be placed in such a way thatthey do not increase the possibility of fire disaster. In case library possess its own generator, the same should be housed away from the library building as normally in generator room or in its adjacent rooms inflammable objects like diesel etc., are stored. Proper maintenance of all electric lines will reduce possibility of fire disaster. Therefore it is better to have a routine checking at regular intervals.

Automatic fire detection and fire extinguishing systems are available and are used in foreign countries. If these systems can be installed, in addition to conscious attempts to avoid fire damages, the librarian and library staff can avoid most of their worry. In automatic fire detection system rise of temperature at any part of a room, sudden increase of light, lightning, appearance of smoke, or several other gases, which are normally produced due to burning, stimulates the sensor, which starts the fire warning signals. By means of special arrangements simultaneously the warning signal may start both in the library and at the local fire brigade office. Through this system automatically bells start ringing and effected areas are also indicated, all air entry points are closed and all the lifts automatically come down to ground floor.

The automatic fire fighting system first controls the fire and then extinguish it. In this work either water or some type of gas is used. Though water can damage library collection, it is now an established fact that automatic water sprinkling system can effectively extinguish fire with very limited damage to library collection. In this system water is used only to that areas, where it is essential. Modern restoration systems for water damaged materials made it easier to use this water based automatic system.

In the gas-based automatic fire-fighting system either carbon dioxide or halon (which is a halogenated hydrocarbon) is used. Carbon dioxide can readily extinguish fire, but as it is injurious to human being it will be better to avoid its use. Halon gas is stored in liquid form in compressed state. It destroys the conditions which help fire to continue. As it has no adverse effect on books etc., and not also injurious to human being it is very suitable for use. This system is very costly in comparison to water based system. Due to false signal or mechanical fault, if this system get operative, it will cost about three lakhs rupees and that is why, it is always preferred to connect directly to the automatic fire detection system. In many cases two separate fire detection systems are installed, to avoid false signal. To ensure the proper functioning, all mechanical systems should be checked at regular intervals and repairing job should be done on priority basis, if necessary.

Whatever may be the facilities of these mechanical systems, most libraries in our country can not even think of installing these due to its prohibitive cost and lack of other infra-structures. Therefore, we have to depend on the conventional systems. We have to keep adequate number of fire extinguisher—both dry and wet types—so that at the time of need they are available ready at hand. Some of them may be kept on movable trollies so that they can be easily moved to appropriate areas quickly. Several buckets should be kept hanging on the wall or on a appropriate stand, some of which should be filled with water and others with sand. As water can not be used for extinguishing elctrical fire ; sand is required for the same. It should be remembered that chemicals in the portable fire extinguisher should be changed after certain period. It is better to have spade, long strong rope etc., as these may be very useful at the time of disaster.

Preservation of Manuscripts

In the chapter, where discussions are made about ancient writing materials, we have seen that before the discovery of paper various materials e.g., clay, stone, papyrus, wood, leather (mainly parchment and vellum), bark, palm leaves, cloth (specially silk) etc., were used as writing medium.

Even though the number of ancient written documents are comparatively few in number—as at that time education was limited to a very restricted elites and also production of written documents were very few, therefore, they are very important and invaluable to us. Most of the documents of that period are now extinct due to aging and other natural causes, but those few which are still available, can give us ideas about developments of that ancient period in the field of science, culture, religion etc. Therefore, it is essential to take every possible care to preserve them in as best condition as possible. These materials are generally known as ancient manuscripts. The job of preserving these are not very simple, as most of these are in a very weak physical condition due to their age. The special conservation system of these materials have two distinct parts—one to prevent further deterioration i.e., the preservation part, which include its storage, handling with extensive care, conscious efforts to resist attack of insects and effects of pollutate atmosphere etc. ; and the second one, to reconstruct the damaged portion i.e., the restoration part. Both the works are complementary to each other. In other words, we can say that the first part of conservation is to save the manuscripts from possibilities of further deterioration in future, whereas the second part is to improve the physical condition of the material which is damaged due to various reasons of the past, so that it can be strengthened and be more suitable for present and future use.

Depending on the material, the repairing and restoration procedures also differ. But all the precesses are extensive, as well as require expert knowledge, and workers engaged in this job, should have full conception about the material, as well as its present condition and also what is going to be done about it. It should always be remembered that any attempt by inexperienced layman to repair or restore may finally led to further decay and even to complete destruction of the material, instead of improvement of its physical condition. There are lots of examples of such destruction as a result of careless and improper restoration attempts both in our country and abroad. In this context the recent case of restoration of paintings of Ajanta cave can be cited.* Only experience and knowledge is not enough, one must have a distinct out-look for restoration job and its aims. Specially in our country, where in every step, we have to face problems of lack of equipments, tools, chemicals, etc., an additional ability to use alternative materials and independent as well as original ideas combined with expert ability is always welcome.

Every work connected with restoration should be viewed as unique and different from all others. Before starting restoration work, all documents should be xeroxed or photographed. In absence of such facilities, it should be copied and documented in as much detail as possible. This is essential both for the present and future workers. Restoration is such a process that it is not possible to utter the final word about it—and therefore, we must try to adopt the latest methods or procedures and before proceeding for this, restorer should calmly think about various pros and cons, e.g.,

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* Jain, Madhu. Ajanta painting : monuments to neglect. *India Today* Vol. 12, No. 5, 15 March 1987. p. 160.

(1) financial side—i.e., if the method is appropriate from the financial standpoint ;

(2) whether equipments, chemicals and finance for this is available ?

(3) whether the method going to be used, is reversible ?

(4) the method should not damage the main material and its components e.g., ink, colour etc. ;

(5) and lastly, the readability of the manuscript should not be affected.

The manuscripts of the oriental countries like India, Pakistan, Sri Lanka., Nepal, China, Japan etc. are mostly made up of birch barks, palm leaves, parchment, vellum, silk, paper etc.

Palm leaf manuscripts

In India, Bangladesh, Burma, Sri Lanka, Indonesia, Malaysia etc., palm leaves were used extensively, both before the use of paper, as well as during the period of early use of paper. In India, it was a popular medium in Bihar, Orissa, West Bengal, Tamilnadu etc., during seventh to twelfth century. Due to the environmental condition palm leaves were also easily available in these areas.

Three types of palm leaves are used in India, they are (a) Tal (Borassus flabellifer), (b) Sri Tal (Corypha umbracauifera), (c) Palm Tal (Corypha taliara). Short description of these are given in the chapter 'Ancient Writing Materials' (page 6—7).

There were several methods to prepare the palm leaves to become suitable writing medium. e.g., in south India til oil was applied on the leaves to make the surface smooth. In Orissa, there were three different methods for preparation of the palm leaves. (1) The leaves were first dried in sun ; then it was kept under mud in marshy places for about 10/15 days after which they were removed and washed thoroughly and dried in sun. Finally tamarind paste was applied on it. (2) Sometimes leaves were allowed to remain in the kitchen (where fire wood was used for cooking) for a long time and subjected to smoke and heat. Leter they were cleaned and tamarind paste was applied. (3) The thick and rough palm leaves were boiled in water for a short time, then they were cleaned which made the leaves more flexible and thinner. Then the leaves were subjected to sun and dew alternatively and finally tamarind paste was applied. Palm leaves prepared in this way were then cut into the required shape and size and in the middle of the leaves a hole was made. Two wooden blocks of the same size were taken which also had holes in the middle and the leaves were placed between the two and a thread was passed through the hole and the whole thing was tied with the thread. The wooden blocks acted as the protecting covers against the possibility of the leaves getting damaged. The presence of the thread in the middle helps to open and easy use, for reading or writing.

Now let us find out how and why palm leaves deteriorates. We can divide the deterioration / damages in several groups e.g., (a) physical and chemical damages, (b) damages caused by fungi, insects etc. ; (c) damage caused by repeated/ constant use ; (d) damage due to improper storage. While examining preservation problems of palm leaves, we can noticed that, (a) basically, these do not have the strenght to withstand the strain of repeated use ; (b) they easily absorbs humidity from atmosphere ; (c) insects readily attack these and mostly damage the edges ; (d) sometime one leaf gets entangled with the next one, which is very difficult to separate ; (e) in some case, it becomes very difficult to decipher the writings on it, due to fading out of ink or use of inadequate ink at the time of writing.

Due to aging and long storing in a condition where both temperature and humidity fluctuates frequently within a broad range, the palm leaves lose its natural oil. The presence of this oil keep it flexible and suitable for use, but in its absence, the leaves become dry and brittle and the surface starts chipping off. Therefore dry and hot weather is its greatest enemy. Another great hurdle in proper preservation of palm leaves is the acidity of atmosphere. Litmus paper can be used to determine acidity of palm leaves.

Though humid atmosphere helps to keep palm leaves in a flexible and usable condition, but in the longrun such weather results in growth of fungi on the medium ; which are apparent from some whitish or greenish or blackish patches that appear on the leaves. In countries having hot weather like ours, the cases of insect attack are also very common ; these insects not only eat up palm leaves, but sometime also leave excreta on it, resulting in entanglement of adjacent leaves, other than dirty markings. In absence of proper use, palm leaves can easily be damaged, specially the edges get brittle, and ultimately destroyed. If the thread is not properly tied, the size of the hole gradually increases. This type of damage can be avoided to a great extent by using silk thread, instead of ordinary cotton thread as that reduces the chances of damage due to abrasion.

If palm leaf manuscripts are stored one above another, the leaves at bottom get damaged due to pressure. It is therefore preferable to store the manuscripts in steel racks, one by the side of the other and the temperature and humidity of the storage area should be maintained within the range of 22° to 25°C and 55 to 60% respectively.

If insect attack is noticed, the best way to eliminate the same is to use fumigation. It has been known from various experiments that if the fumigation is done with either thymol or paradichlorobenzene for seven days in 65% humidity, there will be about 21.5% and 11% damage to the manuscripts.

respectively. Therefore, thymol should never be used for fumigating palm leaf manuscripts. In case of extreme necessity paradichlorobenzene fumigation can be done with adequate care using, 19 gms of the chemical per cubic meter of air and continuing fumigation for 14 days. To prevent insect attack napthalene bricks can be kept on the racks. As fungicide 3% para-nitro-phenol can be used in a methyl alcohol mixture or 10% sodium penta-chloro-phenate mixture in water can also be sprayed or applied with brush on the manuscripts.

Palm leaves absorbs acidity from the atmosphere as in the case of paper. Before deacidifying these leaves, it should be found out if the inscriptions are made on the leaves by scratching on it or not. It may be difficult to detect it in naked eye, but can easily be determined with the help of stereo-microscope. Where writing is done with scratching, dust etc. should be removed with the help of soft brush. After such cleaning often, it has been noticed that there are various spots on the surface which should be removed carefully by using appropriate chemical without damaging the leaves. Then both side of the leaves should be cleaned with a mixture of lime water and rectified spirit (2 : 3) with the help of soft cotton, which should be moved along the direction of the fibres of the leaf for better result. The acidity will be neutralised by lime water. After doing deacidification in this manner the leaves should be dried by keeping them within blotting papers.

If it is found that the writing is not alone by scratching, then, after cleaning dust etc. trichloroethane should be applied on the leaves with the help of soft cotton along the direction of the fibres. In case of illustrated manuscripts deacidification should be done with the help of ammonia vapour. The stains and unwanted marking on the leaves should be removed by using a special type of mixture. This can be prepared by mixing 10 gm of Chloramine T in 25ml. of water and the same is warmed and mixed with 500 ml. of methyl alcohol. After the stains are removed by using this mixture, the clean leaf should be rinsed with 50% methyl alcohol so that any trace of Chloramine T can be removed.

Those palm leaves which have lost natural oil and became brittle, should be treated on both side with a mixture of camphor oil or citronella oil with rectified spirit in a proportion of 3 : 2, till those regain their flexibility. If the writing on the leave is made with scratching, small quantity of graphite powder can be mixed with the solution while applying on the side on which writing is done to make the writing more prominent. After applying the mixture on the leaves, they should be kept in open space for 15 to 20 minutes. Then the same should be cleaned with rectified spirit taken on soft cotton and finally will be kept in between blotting paper under moderate pressure for about 10 to 12 hours. For those palm leaves, whose edges are damaged or the central hole have increased considerably in size, repairing should be done with fresh palm leave of the same thickness from which pieces of required size is cut out with the help of sharp blade or knife and fitted on the appropriate position after applying mowicol or fevicol or similar adhesive with the help of soft and fine brush. In absence of palm leaves, handmade paper of the same thickness can also be used, which will be later coloured properly, so that the repair is not easily noticeable. After the repair is over, the leaf should be dipped in a 5% solution of polyvinyl acetate in toluene, so that the writing ink become permanent and the leaf also gets strengthened.

The alternative way to strengthen the leaf is to put it within a cover of polythene sheet (·03mm to ·04mm in thickness) and subject it to 120°C by using an iron so that the sheet get fixed on the leaf. Cellulose tri-acetate sheet, glued on one side, can also be applied on both sides of the leaf and kept under pressure for two minutes at 60 to 70°C temperature to reinforce the same. The last method is known as Morane type lamination. This lamination not only strengthen the leaves and makes it usable, but also help to protect from future deterioration.

Birch bark manuscripts

Use of barks of trees of birch family was popular in himalayan areas of norther India e.g., Kashmir, Kulu, Manali and adjoining regions during sixth and seventh century. Trees of this family is found to grow in this region in abundance. Just underneath the outer layer of the bark, remains the softer flexible bark, which was collected generally in the form of sheets of 1 meter × 1.25 meter size. Writing was done on these sheets with the help of soft brush in carbon ink. Normally the bark was first slowly dried in air in a room away from direct sunlight or heat, and then oil was applied on it to smoothen the surface and was made ready for use. Several thin sheets such prepared, were kept one above another and put together with the help of natural adhesive. These barks contain certain chemicals (e. g., salts of salicylic acid) which are helpful preservatives and therefore normally insect attack do not occur in case of these manuscripts. But these are susceptible to all other deteriorating environmental conditions excepting acidity.

Like palm leaves, in case of birch bark also, thin layers from surface starts to chip off making it weak and brittle, if kept in an atmosphere where the range of fluctuation of humidity and temperature is high. The edges also turn darker and reddish. Birch bark is not effected by acidity due to its anti-acidic nature. These manuscripts can be damaged due to constant use. The most suitable atmosphere for its preservation is temperature of 22° to 25°C and humidity of 55 to 60%, which should be maintained steadily. In earlier times, these manuscripts were kept in libraries in the from of bundles wrapped in cloth, but this type of storage often damage the materials due to pressure and other allied reasons and therefore, this practice should be avoided. These manuscripts should be kept in good quality cardboard or wooden boxes, so that each leaf can remain separately without being subjected to pressure.

Repair of Birch bark manuscripts : Various types of stain may appear on the bark sheets. No attempt to remove these by use of chemical should be made, as it may seriously damage the sheet itself. Initial cleaning of these should be done with the help of soft camel brush, and then with a solution of glycerine with water, but it is possible only when the ink used in the manuscript is water resistant. In other cases, a solution of Lissapol H in alcohol should be used for this purpose. If it is found that one leaf is entangled to the next one, they should be separated carefully using a sharp knife. But in case of entanglement of a large areas, hot paraffin oil should be used for separation. Use of this oil also cleans all dirt and dust from the surface of the sheet. Sheets cleaned in this method should be dried by placing them on glass sheet. After drying the separated section should be fixed to the appropriate position of the manuscript with the help of carboxy-methyl cellulose adhesive. This adhesive can also be used with the help of soft brush for fixing properly tissue papers on both side to strengthen the sheets. In future if it is decided to further strengthen the manuscript with the use of chiffon or other lamination procedure, these tissue paper can easily be removed.

If the page gets folded, or its flexibility is lost, it should be restored to normal position by applying some type of herbal oil (e. g., citronella oil) on both surfaces of the leaf and allowed to remain undisturbed for 24 hours. It should be remembered that if inspite of carbon ink being used on the manuscript the writing get faded, it is not possible to improve its quality.

Birch bark sheets can be strengthened with the help of chiffon sheet pasted on it with help of ordinary flour adhesive.

Very weak sheets can be placed on hand-made paper and the side on which writing is made, may be covered with chiffon ; this strengthen the sheets. Other than this, Morane type lamination (see page 126) can also be done, which gives very good result.

Parchment and Vellum manuscripts

These mediums were never been used in India extensively, though it was a very popular medium in a vast region starting from Egypt, Greece, Rome to middle and western Europe and also extending upto central Asia. We have discussed its manufacturing systems in a earlier chapter (page 56—61). Let us now concentrate on the aspects of it deterioration. The damages of these materials can be broadly divided into four different groups—(a) physical and chemical damages ; damages caused by (b) insects, (c) constant uses, (d) improper storage systems.

These mediums are more durable then palm leaves and birch barks. Of the two, vellum is more costly, smoother, bright white and more suitable for writing. Normally carbon ink, golden or silver colours are used for writing or painting on vellum. Vellum gets damaged in very dry weather by getting brittle and in too humid atmosphere by getting damped. It becomes yellowish with passage of time. High fluctuation of both temperature and humidity have serious deteriorating effects on it, the surface may be chipped off and colour of ink also gets faded.

Parchment more often get damaged by fungi than vellum. A stable and steady atmosphere (as in case of air-conditioned room) is needed for its proper preservation. In absence of costly air-conditioning arrangements, humidity can be controlled mechanically or chemically. As both vellum and parchment are basically of animal origin, these are prone to attack by insects, rodents etc. Strong boxes or steel almirahs should be used to protect these from this type of attacks.

Usually various stains are found on the surface of the medium as a result of fungi attack ; water should never be used to remove these, as it may damage the material. The best procedure is to clean the surface by removing the spores with the help of soft brush, then a solution of 10% thymol in methyl alcohol is applied on the surface to destroy all traces of fungi grown on it. Alternatively after proper cleaning, it can be fumigated for 14 days using 250 gms of thymol per 3 cubic metre area. But care should be taken to find out if there is any possibility of the ink being damaged by this fumigation ; and in case of any such possibility, this should be avoided. In very humid condition, if the manuscripts are placed within blotting paper, which is saturated with thymol, the possible attack of fungi can be avoided. The mixture which is used as most effective fungicide in case of parchment, is prepared by mixing para-chloro-methyl-cresol with pentachlorophenol each of 0·5% strength. As in most cases the writing or colouring on vellum is made with water soluble materials, water should never be used, until it can be ascertained that water will not make any harm to the manuscript. Vellum can be cleaned by rubbing, for which opaline rubbing pad or similar other material can be used. In case it becomes essential to wash vellum, the washing should be done with alcohol or with a mixture of Lissapol H in alcohol only. To remove the brownish patches from the surface, hydrogen peroxide can be used with the help of sponge with adequate care. For ink markings on vellum Chloramine T solution should be used as advised in the palm leaf manuscript section earlier (page 124-5), but care should be taken to ensure that no trace of the chemical is left on vellum.

To repair wrinkled, vellum, the writing and painting on it should be carefully examined to determine if the same is waterproof or not. If there is no possibility of damage by water, the vellum sheet should be open properly and smoothened and put between blotting paper moisten with a water solution of sodium penta-chloro-phenol of 0·25 strength, which will be placed on a glass sheet and covered by another sheet with moderate pressure and allowed to remain in that position for several days. In case of very badly wrinkled vellum, it will be helpful if the same is kept for sometime in humidity chamber or between two moistened blotting papers, so that it can be flattened properly with much ease. Tightly rolled or folded parchment should be moistened with a solution of 50% alcohol with 10% alcohol urea for sometime before it can be opened carefully and flattened in its original condition ; then it should be kept flat between blotting papers under pressure for atleast seven days.

Small holes in vellum can be closed by rubbing surrounding areas, as rubbed off vellum dust will close the hole. In case of big hole a bigger sheet should be pasted from the back side and a small (exactly of the same size of the hole) piece of vellum should carefully be placed on the front side, and the same should be kept under pressure till the adhesive is completely dried up. These repairs calls for great care and adequate craftsmanship. In case of torn area at the edge, 10% acetic acid can also be used instead of adhesive. If this mild acid is applied on vellum with soft brush in small quantity, it will make the medium gelatinous and soft ; then the torn out edges can be placed in proper position and rubbed lightly and allowed to dry to get the edges fixed. Repairs done in this fashion can not be detected easily and also becomes very durable. The solution, which is used for washing painted vellum, is prepared by mixing 16% alcohol with 10% alcohol urea in water. Where the ink or paint has started flaking, good result can be achieved by applying 5% soluble nylon in methyl alcohol solution or 2 to 5% polyvinyl alcohol mixed in toluene with the help of soft brush on the effected area.

Paper manuscripts

From earlier discussions, we have known how paper is manufactured and various other factors related to it (page 20-42). As regards preservation of paper manuscripts, first of all, we must examine the same very carefully. Most old paper manuscripts, which come for repairing, emits a dampy smell, which is indicative of earlier or present fungi attack. Sometime some markings or stains are found, which are also of fungi origin. The best step against fungi attack is fumigation. To remove the stains ethyl alcohol or benzene can be used. As both the chemicals are highly inflammable adequate care should be taken at the time of use.

Paper may turn acidic due to its manufacturing defects or environmental conditions in the storage area. Due to increase in acidity, paper turns yellowish and brittle. Acidity can be easily determined by using blue litmus paper. The deacidification procedures are discussed in chapter dealing with paper (page 34-40).

Occasionally while handling very old papers, we come across excreta / dead bodies / eggs of insects. Sometime eggs are not visible in naked eyes. In such cases fumigation will give the best results.

Before preservation of paper manuscripts, the nature of the ink used, should be ascertained by some simple tests—(1) A drop of 5% acetic acid should be dropped on the corner of a ink marking ; after few minutes it should be blotted up by a fresh blotting paper. Now 1% potassium ferro-cyanide mixture is dropped on the part of the blotting paper, where the acid is blotted ; if blue colour appears on the blotter, then the ink used is iron based. (2) A drop of sodium hydroxide .solution should be dropped on one corner of ink marking, which should be blotted with a fresh blotting paper. If dark reddish brown colour appears on the blotter, then the ink contain iron compound. If brown marking appears, then the ink contain logwood. We have already discussed various types of ink and their natures quite elaborately in an earlier chapter (page 42-51).

Before starting repairing work, apart from nature of ink, we have to determine certain other things about the paper also. It will be helpful for repairing job, if we can know about the main constituent of the paper which can be done very easily through some simple tests, e.g., (A) If it is found that on applying iodine, a very light (almost colourless) brownish patch appears on the paper, then it can be inferred that chemical wood fibre, grass or straw is used as raw material. If the marking is of yellow to brown, then it can be inferred that mechanical wood pulp is used to manufacture the paper. If the marking is dark brown, then it can be said that cotton or silk fibres are used in the pulp. (B) On application of zinc chloro-iodine, if yellow marking is formed on paper, then it can be said that the main ingredient is mechanical wood. If the marking is of blue colour then the ingredients consist of chemical wood, straw, grass etc. If the marking is of strong wine colour then the ingredients consists of cotton or silk fibre. (C) On application of fluroglucinol solution, if dark red marking appears, then it indicate that the paper is made up mainly of mechanical wood pulp. (D) On application of Hergberg's dye, if red colour appears, it indicate presence of cotton and silk fibres ; if blue marking appears, that will indicate presence of chemical wood pulp and in case of yellow marking, presence of mechanical wood pulp.

After the examination of paper and when the fumigation is over, the documents will be cleared of dust etc. Various marking may appear on paper, which can be removed with application of appropriate chemicals ; but before using any chemical, it should be ascertained that, it will neither harm the ink nor the paper. The carbon ink is not affected readily by use of chemicals. The iron gall ink can be cleaned by erasing after improving its conditions with appropriate chemicals and proper deacidification. But preservation can not be completed until the ink is made permanent by application of resin. For making ink permanent, the following chemicals can be used—(A) 3·5% soluble nylon solution in alcohol; (B) 0·5 to 1% polymethyl methacrylate solution in toluene; (C) 1 to 2% polyvinyl acetate solution in toluene; (D) 2 to 10% bedacryle solution in acetone or xylene. In case of synthetic ink it should be first determined whether it is soluble in water or not and what are the effects of other solvents on it. Sandofix should be applied on synthetic ink to make it permanent, and then only other steps for preservation or repair can be taken up. In case of printed books this type of problems do not appear as the printing ink is much more stable and permanent.

Sometime paper becomes very weak due to acidity and deterioration—those should be deacidified first and then resized to make it durable. The deacidification method is to be selected with great care specially in case of manuscripts where non-permanent ink or colour is used for writing or illustrations. Dirt, dust, fungi marking etc., can be removed with help of alcohol. In case of illustrated manuscripts ammonia gas 1 : 10 mixture can be used for deacidification.

The pencil marking / writings on manuscripts are not affected by deacidification or fumigation. If the markings / writings are outside the printed or written area i.e., in the margin, then 5% solution of polyvinyl acetate in toluene can be used with the help of soft brush to protect it from damage during various reactions that may be undergone for preservation.

Occasionally it is found that though the manuscripts are in a fairly durable condition but, due to wrinkling or folding of pages or sheets, some problems are created. If the physical condition is good, it is not very difficult to make those pages flat with the application of certain amount of pressure and tension and then put them within moistened blotting paper and keep it in that position for few weeks under moderate pressure. In this method, if the blotting paper is not moisten with water but with 0·25% mixture of thymol in alcohol or 0·01% sodium orthophenyl phenate is used, then as this process goes on, the traces of insects or fungi (if any) will be eliminated.

Fumigation : What and Why

There are several chemicals which are volatile i.e., they evaporate, if left open, either in normal room temperature or with slight rise in the same. As the vapour of some such volatile chemicals are poisonous to the insects, fungi etc., those can be used for protection against such enemies of the library collections. This method is known as fumigation. Gaseous poisons used to kill insects etc., are called fumigants. The chemicals which are normally used for this purpose are either liquid or solid in normal condition. In those libraries where the problems of fungi and insects attack are moderate to high, or where there are enough possibility of such problems, fumigation will prove to be an extremely effective measure.

In the areas where rainfall is quite high, cases of fungi attack, to full or part of the library collection, is not very rare. The first sign of fungi attack indicate that the internal environment in the library is not suitable to conservation—atmosphere is moist, i.e., the relative humidity is high, and arrangement of light and air circulation is not adequate. These environment should be rectified immediately by taking various necessary measures. But for the collection, which is already effected, application of fumigation is essential to get rid of fungi and insects.

There are two types of fumigation—ordinary and vacuum fumigation. Before we proceed to discuss, in some detail, about each fumigation system, let us find out different chemicals which are used for various types of fumigation. Those chemicals are—(1) Ethylene oxide (1 part) and Carbon dioxide (9 parts) mixture (this can be used in vacuum fumigation only) ; (2) Thymol ; (3) Formaldehyde ; (4) Paradichlorobenzene ; (5) Carbon tetrachloride and Ethylene dichloride (mixture of 1:3) or Carbon tetrachloride (8 parts) with Carbon disulphide (20 parts) ; (6) Methyl bromide ; (7) Carbon disulphide ; (8) Hydrocyanic acid gas.

Vacuum Fumigation

Vacuum fumigation is recognised as most effective system. For this system a special type of steel fumigation chamber is necessary. Generally these chambers have a capacity of 10 cu. meter (i.e., 353·2 cu. ft.). Within the chamber books, which are to be fumigated—are kept either on book trolley or on shelves. The door of the chamber—which is air tight, is locked properly and air from the chamber is pumped out. After removing all air, about 4 to 5 kgs (8·8 to 11 lbs) of ethoxide gas is introduced with the help of electric pump. Ethoxide gas is prepared by mixing 1 part ethylene oxide with 9 parts of carbon dioxide. This gas can destroy both fungi and insects within a very short period and can enter in all the parts of books/documents easily, even if they are kept in a tightly compact form.

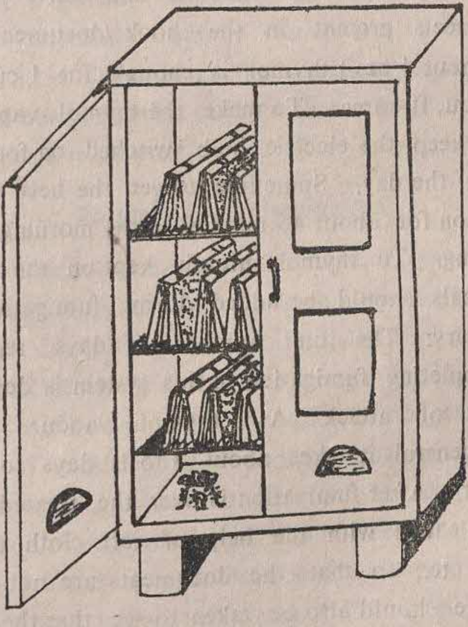
Another very significant factor of this system is that it destroys not only fungi and adult insects but also spores and eggs ; this facility is not available in most fumigation systems. The ethoxide gas do not have any adverse effect on library collection. This system require about three hours to complete and therefore after three hours the gas is pumped out and replaced by air and the fumigated materials are removed from the chamber.

The main disadvantage of this system is the high price of the necessary equipments. In our country it is beyond the reach of most of the libraries. The cost of such machine was around 1 lakh even 12/13 years ago. But with the introduction of some comparatively smaller machine in the market the price has now come down to 25/30 thousand rupees. Even in foreign countries several medium size libraries cooperate to install one such machine. The gas used in this system is fully non-combustible and non-injurious to man.

Thymol Fumigation

From the standpoint of popularity and extensive use, Thymol fumigation is the most important system. Thymol is bright white crystal with pleasant odour. It is non-inflammable and evaporates with application of slight heat. It is quite effective and comparatively easy to use.

A fumigation chamber is necessary for this system. Generally a wooden almirah of 1·8m × ·75m × 1·35m (i.e., 6′ × 2·5′ × 4·5′) size can be used as the chamber. The inner side of the almirah should not be coloured or varnished.



Rubber gasket or lining should be fitted on the door of the almirah to make it airtight. There should be a removable shelf made up of net or messing or perforated stainless steel at a height of about 15 cm (6 inches) above the bottom. Above this shelf at a gap of about 45 cm (18″) two other similar shelves are fitted. Just below the bottom shelf in the 15 cm space, a 40 watt electric bulb is fitted, above which an arrangement is made to keep a small porcelain or glass plate with thymol crystals. But in absence of required fumigation chamber, ordinary box or almirah can be effectively used after making certain modifications. The books to be fumigated are placed on the shelves in slightly open condition in reversed 'V' form, so that the spine of the book remains on top (as shown in the Figure, page 137). As the chamber is airtight, when the electric light is switched on, thymol gets evaporated by heat of the lamp. The vaporised gas get mixed with air inside the chamber and starts reacting on fungi or insects present in the books/documents. About 115 gms (about 4 ozs) thymol is enough for 1 cubic meter (about 35·3 cu. ft.) area. To make the thymol vaporize, it is necessary to keep the electric bulb switched on for about an hour during the day. Sometime to get the best result, the light is kept on for about 45 minutes in the morning and again in the evening. To thymol initially kept on the container, fresh chemicals should be added during fumigation, as and when necessary. The total number of days required for properly completing fumigation in this system is dependent on the severity of attack. As thymol vapour acts very slowly, in general it takes about 8 to 10 days to complete one treatment. After fumigation is over, the treated materials should be cleaned with the help of soft cloth to remove dead insects etc., so that the documents are not damaged. Adequate care should also be taken to see that the spores of fungi are not spread during cleaning, as that may cause fresh attack on other books, because spores are not destroyed by thymol vapour.

Thymol vapour do not have any adverse effect on human being ; but has serious damaging effect on several types of ink, oil painting, palm leaf materials and some other materials on which varnish is used, Therefore, these type of materials should never be subjected to thymol fumigation.

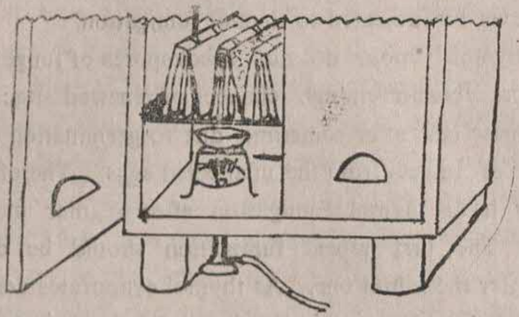
As thymol vapour do not effect spores of fungi or insect eggs, there remain enough chances of renewed attack on the treated materials after sometime, due to germination of spores or birth of insects from the unaffected eggs. Therefore, it is better to have thymol fumigation after regular intervals, if possible. The first repeat fumigation should be done 2/3 months after the initial one. As thymol evaporates very easily, no residual effect remains in the documents treated and therefore cannot provide any permanent or long lasting protection to the materials treated.

This is an extremely effective fumigation system, suitable for even smaller libraries as the chemical required is easily available and comparatively cheaper then other fumigants and the method is quite simple.

Formaldehyde Fumigation

Among the most extensive used fumigation systems, formaldehyde is next only to thymol. In this system formaldehyde is used, which is a light brownish liquid with a pleasant smell.

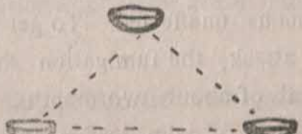
For formaldehyde fumigation an airtight wooden chamber of 1·8m × ·75m × 1·35m (6′ × 2·5′ × 4·5′) size is generally used. In absence of such chamber wooden almirah or box can also be used by making them airtight with the help of rubber gasket or felt. A removable shelf of metallic net or messing or perforated stainless steel is fitted about 15 cm. (6″) above the bottom, above which with a gap of 45 cm. (18″) two other similar shelves are fitted in the chamber. Under the bottom shelf in 15 cm. (6″) space 40% formaldehyde (a mixture of 20 parts water with 2 parts formaldehyde by weight) is kept in small container made up of porcelain or glass. There should be an arrangement to heat the container by means of spirit lamp or similar other method. In some cases vaporization of



formaldehyde is done in a small container kept close to the chamber to which the gas is transmitted. The temperature inside the chamber is maintained at 30° C with the help of electric lamp or some other device. In this system also, books are kept on shelves in such a fashion that the chemical vapour can easily enter books/documents etc. Books should be placed in reversed 'V' form as in case of thymol fumigation. This fumigation takes two days to complete one treatment. Formaldehyde fumigation is very effective against fungi and insect attack, but the main disadvantage of this system is, its adverse effects on binding materials e.g., adhesive, leather etc. Several types of ink pigments are also damaged by this. Materials of leather, parchment, vellum etc., should not be subjected to this fumigation to avoid damage. As this system do not destroy spores or insect eggs, a repeat fumigation, after about three months, is necessary, to prevent reoccurrence of fresh attack.

Carbon Disulphide Fumigation

The chemical that is used in this system is carbon disulphide, which is a colourless liquid with offensive smell, and evaporates automatically in contact of air. The gas is highly inflammable and can be ignited with contact of even lighted cigarette. In this fumigation system also, an airtight wooden chamber of 1·8m × ·75m × 1·35m (6′ × 2·5′ × 4·5′) size is usually needed. removable shelf of metallic net or messing or perforated stainless steel or wood is placed about 15 cm. (6″) above the bottom and at a gap of 45 cm. (18″) above this two similar shelves are fitted. Below the bottom shelf three small porcelain or glass crucibles each carrying about 56·7 gms (2 oz) of carbon disulphide are placed in such a way that they remain in three apexes of an imaginary triangle. The books to be



treated are placed on the shelves either in open condition or in reverse 'V' from, so that the spines remain on top. After seven days again a fresh supply of carbon disulphide should be added. The door of the chamber is closed tightly and allowed to remain for another seven days. This fumigation require two weeks to complete one treatment, within that period all fungi and insects are destroyed, though the eggs and spores remains unaffected. To prevent reoccurrence of fresh attack due to presence of these eggs and spores, fumigation should be done again after a short interval of 2/3 months. The gas can very easily enter the book and react on pests though slowly ; but the major disadvantage of this system lies in high inflammability of the chemical, which makes it somewhat risky to use, unless done with adequate care.

Para-dichlorobenzene Fumigation

The chemical used in this method is para-dichlorobenzene, which is a white crystalline substance with mild ether like smell, that easily evaporates in normal atmospheric condition giving rise to a non-inflammable gas.

In this system a normal airtight fumigation chamber (one used for thymol or similar other fumigation) can be used. The chemical is placed in three glass crucibles on the floor of the chamber. Effected books are placed on the shelves in open or semi-open form and than the door of the chamber is closed tightly. One kilogram (2·2 lbs) of para-dichlorobenzene is enough for 1 cu. metre of air. It takes about 7 to 10 days to complete the fumigation. In this system also the spores and eggs of insects remains unaffected. To get best result and to stop the renewed attack, the fumigation should be repeated after a short interval of about two months. This method can be used for fumigating of palm leaf manuscripts with proper care.

Carbon Tetrachloride and Ethylene Dichloride Fumigation

The chemical that is used in this fumigation system is carbon tetrachloride, which is a colourless liquid that slowly evaporates to a non-inflammable gas with smell similar to that of chloroform. As this gas has a very slow action on insects, it alone cannot be used for fumigation. Ethylene dichloride is highly inflamable heavy liquid, with a pleasant smell. A mixture of 1 part carbon tetrachloride with 3 parts of ethylene dichloride is very effective fumigant. As this evaporates in normal room temperature it is very convenient to use, for fumigation purpose. This mixture reacts very quickly and comparatively less inflamable. In this fumigation system also an airtight wooden fumigation chamber, similar to the one used for thymol or similar other fumigation, can be used. For fumigation ·25 litre (·55 gallon) of the mixture is enough for 1 cu metre air. This method takes about 24 hours to complete one treatment. To get the best result the temperature within the chamber should be maintained between 25 to 30°C. Due to moderate inflammable narure of the gas, it is necessary to take adequate care during its use.

A mixture of 8 parts carbon tetrachloride with 20 parts of carbon disulshide (inflammable), which is liquid, but gets evaporated easily in contact of air, can be used for fumigation quite satisfactorily. Here also ordinary airtight chamber, as the one used in thymol fumigation, can be used. In both the above fumigations the spores and insect eggs remain unaffected requiring refumigation after about 2/3 months to avoid renewed attack.

Methyl Bromide Fumigation

The chemical used in this process is methyl bromide, which is a colourless, almost odourless, non-inflammable gas. This is stored in cylinders, in liquid form, under high pressure. In gaseous condition, it can easily penetrate in books and documents making it very suitable for fumigation purpose. An ordinary airtight wooden chamber can be used, for this fumigation. This system normally requires about 12 to 16 hours to complete one treatment, but as its effect on certain insects are quite slow, it is better to continue fumigation for 24 to 28 hours. This fumigation should be done with adequate care and precautions as this chemical is very poisonous to all living being including mnn. As this fumigation destroy the spores and insect eggs, it is not necessary to repeat, as in case of most other fumigations.

Hydrogen Cyanide Fumigation

The chemical used in fumigation is hydrogen cyanide, which is a colourless highly inflammable gas in ordinary temperature and is lighter than air, though can readily mix with it. It can be stored in liquid form under high pressure. In gaseous state it can readily enter in books, documents etc. and can act as a very strong and effective fumigant. In this case also ordinary perfectly airtight wooden fumigation chamber can be used ; but enough precaution should be taken during this fumigation as this chemical is highly poisonous to animals as well as human being.

It will not be out of context to discuss how the fumigants act on different types of insects. Fumigant enter into the body of insects through their respiratory system or skin and effects their nervous system. As the fumigant gases reach the cells of the body of insects, they have poisonous reactions on the protoplasm, resulting in death. Several types of insects can contract their respiratory organs after coming in contact of poisonous fumigants and therefore it takes more time to complete the fumigation.

All the eight types of fumigations which are discussed here are compared in tubular form in the next page.

ns	Necessity for Repeat Fumigation	Remarks
e. Not injurious . Do not have fect on tion.	Not Necessary.	Costly method; mainly due to high cost of the required equipment.
e. Not injurious . Have adverse painting, several nd palm leaves.	Repeat fumigation required after 2/3 months to prevent re-attack due to germination of spores and hatching of insect eggs.	Comparatively cheaper method.

VARIOUS POISONOUS CHEMICALS USED FOR CONSERVATION JOB

There are various problems in library conservation, of which most important is attack of various insect pests, fungi etc., regarding which, we have already discussed in earlier chapters. To protect library collections from these, different types of poisonous chemicals are used, which can be broadly divided in several groups e. g., (1) Stomach poisons, (2) Contact poisons, (3) Respiratory poisons, (4) Insect repellents (which makes the environment unsuitable for insects to live in). It should be remembered that some poisons can act in more than one way i.e., a poison, which acts as stomach poison, can also act as contact poison and so on.

Stomach poison

Stomach poisons can be applied only against such pests, which takes them together with their food. The poison starts its action in the stomach or intestinal tract of the pest. This type of poisons, which include Aldrin, Arsenic trioxide, Barium carbonate, Boric acid, Mercuric chloride etc., are very effective against cockroaches, white ants, beetles etc. and also against rodents.

Aldrin ($C_{12}H_8 C_6$) : This is a crystalline substance insoluble in water but soluble in alcohol, ether, benzene. It can be applied by mixing with food staff to kill rodents. It also acts as an effective insecticide.

Arsenic Trioxide (As_2O_3) : It is a transparent white substance which is slightly soluble in water. It is a very strong poison for all living creatures. For eradication of rodent, this can be applied by mixing with food materials. This is also known as White arsenic.

Barium Carbonate ($BaCO_3$): It is a white heavy powder, which is insoluble in water, but soluble in strong acids. Though it is a mild poison for domestic animals, it acts as a strong poison for rodents. It is normally used in form of 20% aqueous solution.

Boric Acid (H_3BO_3): This is available in form of colourless odourless powder or crystalline substance, which is slightly soluble in water. The aqueous solution is used as fungicide and also to eradicate bacteria.

Calcium Arsenate (Ca_3AsO_4): This is a cheap, very poisonous crystalline powder, which is slightly soluble in water. It is used by spreading or by spraying. Generally it is used in form of a mixture of 8 parts of lime with 1 part of the chemical. Care should be taken to ensure that it is not inhaled or reach the stomach due to careless handling at the time of application. It is a comparatively unstable poison.

Chlordane ($C_{10}H_6Cl_8$): This is a coloured liquid insoluble in water, but soluble in kerosene and some other petro-chemicals. For rodents this is applied by mixing with food materials and sprayed while used as insecticide. It can also be used for fumigation. It gives very good result while applied in soil to control white ants (termites). In several countries its application is banned, except the use in soil against termites, due to its polluting effect on environment.

Cupric Arsenite ($Cu_3(AsO_3)_2$): This is a yellowish-green powder, also known as Paris green, which is insoluble in water. It is extensively used to prevent attack by termite/ powder post beetle on wood, and also acts as a very effective fungicide. It can be used against rodents by mixing with food materials.

Dicapthon ($C_8H_9ClNO_5PS$): It is a crystalline substance insoluble in water but soluble in acetone, ethyl acetate, toluene etc. and in several types of oil. To eradicate rodents, it is applied with food materials. It is also an effective insecticide.

Dieldrin ($C_{12}H_8Cl_6O$) : This is a crystalline substance which is insoluble in water but soluble in xylene and similar other solvents. This is used by mixing with food materials to kill rodents ; and also an effective insecticide. At the time of application adequate care should be taken, as it can easily enter body through skin and may start poisonous effects.

Dimpylet ($C_{12}H_{21}N_2O_3PS$) : It is also known as Diazinon. It is a liquid with mild odour which is soluble in water, alcohol, ether, benzene etc. It is an effective insecticide.

Lead Arsenate ($PbHAsO_4$) : It is a white heavy powder which is insoluble in water. It is a comparatively stable poison, and can be used in powder or aqueous form. It is very effective against larvae of moths and bookworms (larvae of beetles).

Lead Carbonate [$(PbCO_3)_2Pb(OH)_2$] : This is a white crystalline substance also known as White lead, which is slightly soluble in water, but easily soluble in ammonium acetate. It is an effective insecticide.

Lindane ($C_6H_6Cl_6$) : It is a crystalline substance with moderate odour, which is insoluble in water, but soluble in alcohol, benzene, ether etc. It is available in different forms of which gama-isomer form is the strongest insecticide. It is less poisonous to higher animals and human being. Generally it is used in powder form by spreading, but can also be used by spraying in a mixture form with kerosene oil. One of its special form is popularly known as gammexane. It is also known as Benzene hexachloride or B.H.C. It is very effective against cockroach, silverfish, bristletail etc., but not so affective against some other insects like several caterpillars. It is more effective as contact poison. If kept open for a long time, it will lose its strength and effectiveness and as a result do not create environmental pollution problems in spite of continuous use.

Mercuric Chloride ($HgCl_2$) : This is a white powder, also known as Corrosive sublimate and slightly soluble in water. It is very strong poison and can be very effectively used as fungicide and also for protecting wooden furniture etc. from termite attacks. It is also used against rodents by mixing with food materials. Adequate care should be taken during its use as it may cause serious poisonous effect on human being as well as domestic animals.

Mercurous Chloride (Hg_2Cl_2) : This is a white heavy odourless powder which is almost insoluble in water. It is very strong fungicide. But it should be used with enough care to avoid any possibility of accidental poisoning This should also be stored away from light, otherwise gradually it will be converted to Mercuric chloride.

Pentachlorophenol (C_6HCl_5O) : This is available in needle shaped crystals, which is almost insoluble in water but soluble in alcohol, ether, benzene etc., and emits strong smell when heated. It is used with food materials to control rodents. It is also very effective against termites and other insects. Often it is mixed with adhesive, to be used for binding, to protect the binding from insect attack, which also acts as an effective fungicide. As it can enter through the skin easily, enough care should be taken to avoid any accidental poisoning.

Sodium Arsenite (Na_3AsO_3) : This is white or whitish gray powder which is readily soluble in water. It is very effective in protecting wooden materials against insect attacks (specially termite/powder post beetles).

Sodium Borate ($Na_2B_4O_7$) : It is a odourless hard crystalline substance, popularly known as Borax, which is slightly soluble in water. This is an effective fungicide and also can be used for making wood fire-resistant.

Sodium Fluoride (NaF) : This is a white granular substance which is slightly soluble in water. It is a very strong poison which can be used by mixing with food materials to kill rodents etc.

Sodium Hexafluorosilicate (Na_2SiF_6) : This is a white granular substance, also known as Sodium fluorosilicate, which is slightly soluble in water. It is used to eradicate rodents and also as an insecticide, specially against moths to protect warm cloths and similar other materials.

Trichlorobenzene ($C_6H_3Cl_3$) : This is a granular substance which is insoluble in water but slightly soluble in alcohol and easily soluble in carbon disulphide and benzene. It is a very effective insecticide specially used against termites.

White Phosphorus (P) : This is a white or transparent substance, with distinct odour, which is almost insoluble in water. If left exposed in air, it turns blackish due to chemical reaction. In darkness yellowish light is emitted due to reaction with air. It is a very strong poison. Due to offensive smell most of the animals avoid this, but rodents readily take food mixed with this chemical. To get best result fresh chemical should be used, as it loses its poisonous character if remain exposed for very long time.

Zinc Chloride ($ZnCl_2$) : This chemical is a odourless white granular substance which is soluble in water. It can easily absorb humidity from atmosphere and have damaging effect on cellulose. This can be used to eradicate rodents by mixing with food materials.

Zinc Ortho-arsenate ($As_2O_8Zn_3$) : This chemical is a white odourless powder which is insoluble in water, but easily soluble in ammonia, acid and alkali. It have an extensive reaction on the digestive system specially on younger rodents than adult ones.

Zinc Phosphide (Zn_3P_2) : This chemical is a dark gray or blackish substance with strong phosphorus smell. Though the smell acts as repellent to most of the animals, it is attractive to rodents. This can be used at a proportion of 1% with food material. If left exposed, it readily absorbs moisture from atmosphere and loses its poisonous character.

Contact Poison

This type of poison is effective only in the cases where the insects come in direct contact with the chemicals. These actually act as a nerve poison. As soon as insects walk over or come in contact with the poison, the same penetrates in the insect body by way of the sensual organs or the soft synovial membrane and progressively attack the nervous system, resulting in symptoms of paralysis, which may lead to death. The time taken for the onset of poisonous effects differs. This type of chemicals includes nicotine, pip, begon, shelltox, finit, DDT and several types of chlorinated hydrocarbons, pyrethrine, and phosphorus compounds e. g., malathion etc. The last two compounds mentioned are also occasionally used as stomach poison by mixing with food materials.

Begon/Shelltox/Finit/Pip : These are petro-chemical based solutions which are normally used by spraying. In general these are quite effective against most of the insects. These chemicals with strong smell remains effective for 5 to 7 days after spraying and therefore to get the best result, it should be sprayed regularly once in every week.

DDT (Dichloro-Diphenyl-Trichloroethane) ($C_{14}H_9Cl_5$) : This is a chlorinated hydrocarbon. 70/75 percent of the total insecticides that are used all over the world belong to this group. The most convenient factor of this chemical is that it is a moderately stable compound. It is possible to control insects and rodents by spraying this chemical on areas where they live and on their regular movement routes. It can act both as stomach and contact poison. It is now proved beyond doubt that due to its continuous use for a considerable long period many insects have already became resistant to this chemicals and have created problems of environmental pollution. In view of these problems in many developed countries restrictions are imposed on its use.

Malathion ($C_{10}H_{19}O_6PS_2$) : This is a yellow to dark brownish liquid with strong offensive smell. It is a phosphorus compound which is slightly soluble in water. It loses all its insecticidal properties at higher temperature. It is very convenient to use, as though highly poisonous to insects, do not have any damaging effect on domestic animals or human being. It can be used by spreading in powder form or by spraying after mixing with some solvents. It is less poisonous in comparison to DDT. This chemical is highly inflammable and should be carefully stored away from fire.

Nicotine ($C_{21}H_{14}O_2$) : This is a light yellow coloured or colourless oily liquid. If kept open for a long period, it changes colour to dark brown which is soluble in water. It is available in tobacco plants in form of alkaloid. This is normally used in 95% strength or in form of nicotine sulphate (which contain about 50% alkaloid nicotine). This chemical is very effective against the insects who are not effected by arsenic compounds. To eradicate rodents this can be used by mixing with food materials.

Pyrethrine ($C_{21}H_{28}O_3$ or $C_{22}H_{28}O_5$) : It is a vegetable oil—extract of pyrethrum flower—which is available generally at 25% strength. Though insoluble in water, it is readily soluble in kerosene and some other solvents and are generally used in form of mixture. It is poisonous to insects but do not have any adverse effect on domestic animals or human being. The main disadvantage of this chemical is that it loses its effectiveness very easily after reacting with air and therefore, it is mainly used by spraying to get comparatively short-term effect. Now experiments are going on to find out if its effectiveness can be made longer lasting by mixing it with some other chemicals.

Respiratory Poison

The respiratory poisons become effective after being introduced in the body in gaseous form through the respiratory system, the lungs etc. This type of poison include Methyl bromide, Carbon disulphide, Ethylene oxide, Hydrogen cyanide, Paradichlorobenzene, Thymol, Formaldehyde etc. Generally this type of poisons are also used for fumigation.

Carbon Tetrachloride (CCl_4) : This is a non-inflammable colourless heavy liquid with moderate smell, which is slightly soluble in water, but readily soluble in ether, alcohol etc. It is generally used as insecticide in gaseous form but can also be used by mixing with highly inflammable poisonous chemicals to avoid fire accidents or explosions. It can also be used for extinguishing fire.

Carbon Disulphide (CS_2) : This is a inflammable liquid with strong smell which is used as very effective insecticide. It becomes explosive by reacting with air. In gaseous form it is heavier than air and can also be used as a fumigant but have adverse reaction on human being resulting strong headache, nausea etc. as the primary symptoms. In case of serious poisoning it may result in paralysis and even death. It is more damaging to those, who have heart ailments.

Ethylene Dibromide ($C_2H_4Br_2$) : At normal room temperature it is a heavy liquid with smell very similar to that of chloroform, which readily evaporates to form a non-inflammable gas. Other than its use in fumigation, it can be used by mixing with food materials against rodents. It is cheap and comparatively easy to use. If prolong contact with skin is allowed, it may result in wounds ; long exposure to its vapour will damage liver, kidney, lungs etc.

Ethylene Dichloride ($C_2H_4Cl_2$) : This is a heavy liquid with pleasant smell which is slightly soluble in water. The vapour is inflammable and an effective insecticide. It can also be used by mixing with food materials against rodents.

Ethylene Oxide (C_2H_4O) : This is a colourless inflammable gas which is soluble in water, ether and alcohol. It is a very effective fungicide as well as insecticide, which can also be used for fumigation purpose.

Formaldehyde (CH_2O) : This is a colourless inflammable gas with strong smell. It is generally used in form of a solution of 37% strength in water, which is colourless but have a strong smell. On evaporation it gets converted into a small amount of formaldehyde gas and rest in trioxymethylene. It is used for fumigation. It have adverse reaction on human being.

Hydrogen Cyanide (HCN) : This is a very strong poisonous gas with a pleasant smell. This chemical can easily enter inside animal cells and escape after very short period and effect the tissues in such a manner that they can not absorb or use oxygen and are destroyed. A very small amount of it can effectively destroy insects, rodents etc. It have poisonous reaction on all living beings and therefore should be used with extreme care. Often it is mixed with 2% Chloropicrin gas to easily detect its presence by the strong smell.

Methyl Bromide (CH_3Br) : This is a colourless and almost odourless liquid under high pressure. If kept in a open container in normal atmospheric pressure and temperature it easily evaporates. Its boiling point is 45°C. In gaseous state it is heavier than air. It can destroy all (from eggs to adult) stages of insects and can easily penetrate in various objects and therefore is a very effective fumigant. It can produce serious problem as its presence in air is not easily detectable ; to counteract this, in most cases 2% Chloropicrin gas is mixed with this, to indicate its presence in the vicinity. Even when small amount of it enters our body, a part of the same remains inside creating serious problem in future, when the accumulation crosses the danger level. It creates burn wound when come directly in contact with skin.

Naphthalene : This is a white crystalline substance which evaporates very easily. It is almost insoluble in water, but soluble in ether, alcohol and benzene and vere effective against insects specially moths etc.

Paradichlorobenzene ($C_6H_4Cl_2$) : This is a white crystalline substance which evaporates in normal room temperature if kept open. It is insoluble in water, but soluble in alcohol, ether, benzene etc. In gaseous state, it have a mild ether-like smell. Other than its use as an effective fumigant, it is also used against rodents by mixing with food materials.

Insect Repellents

There are certain chemicals which are either very mild poisonous or non-poisonous but have a evil taste or smell for insects etc., and therefore they try to avoid these materials and keep away from the areas where these are kept. These type of chemicals are generally known as insect repellents. One and single chemical may not act as repellent for all insects. These repellents may be of different types—one group which includes trichlorobenzene, creosote etc. are very effective against the crawling insects like termites, cockroaches etc. ; another group —repellent against the feeding of insects—which include DDT, Sodium fluorosilicate, oil of ceder etc., are effective against insects which attack cloth and similar other materials e.g., moth, cloth moth, carpet beetle etc.

First aid in case of accidental poisoning

Almost all chemicals which are used as fungicide, insecticide, rodenticide etc., have some poisonous effects on domesticated animals, birds and also on human being, though the degree of effect differs from chemical to chemical. Therefore these chemicals should be stored, handled and applied with adequate care and enough precautions. Every container of such chemicals should have distinct levels, which should bear ` the name, and marked as

"Poison" and also any special information about the specific chemical that may be necessary. It should also indicate the antidote of that particular poison. Before using any poisonous chemical the level should be read carefully and instructions should be followed meticulously. In comparison to the huge production of poisonous chemicals and their massive use, the number of cases of poisoning is very low. The cases of poisoning happens mainly due to following reasons—

(1) inadequate knowledge about the chemicals used ;

(2) careless handling ;

(3) not properly following the instructions given regarding use ;

(4) malevolence i.e., desire to do evil to others.

To avoid accidental poisoning the following steps should be taken :—

(1) Before using any poisonous chemical, one should know about the poisonous effects of the same and this should be conveyed to all who may come in contact with the chemical ;

(2) Chemicals should be carefully kept in locked almirahs or boxes, so that no ignorant/careless worker can handle these ;

(3) All containers must have distinct level carrying the name and also prominent marking "Poison" on it.

(4) These chemicals should never be stored in vicinity of food materials.

(5) The room, where the chemicals will be handled, should be well-ventilated ;

(6) Adequate care should be taken at the time of handling, so that the chemicals do not come in direct contact with skin, eyes, etc. ;

(7) Places where poisonous chemicals are used, should have emergency first-aid kits and necessary antidotes ready at hand ;

(8) The telephone numbers of nearby hospital, doctors

and similar other information should be readily available by the side of the telephone ;

(9) Enough supply of drinking water and clear water for other uses, should be readily available.

In spite of all precautions, accidents may happen and therefore one must know about the steps to be taken immediately in case of such occurrences. The main steps are :—

1) Immediate arrangement for providing first aid should be made. It should be remembered that quicker first-aid brightens the chances of early recovery ; as in most cases it is often found that the poison have spread adequately causing serious damages before the doctor can start treatment ;

2) Arrangements should be made to bring doctor as early as possible ;

3) The patient should be removed from the room (laboratory, fumigation room) or area where poisoning started and preferably allowed to lie down in open air ;

4) All poisonous materials should be removed from the vicinity of the patient ;

5) The unconscious or semi-conscious patient should be laid down with face downward, so that the head may rest on one side and tongue remain in such a position that respiration is not hampered ;

6) Care should be taken to see that body temperature of the patient do not rise or fall abruptly ;

7) Patient should not be allowed to remain alone ;

8) If necessary, artificial respiration should be carried out ;

9) Without doctor's advise brandy or other stimulants should not be given, as in some poisoning cases, it will have adverse reactions ;

10) The first-aid should be continued till the doctor arrives and takes charge.

11) Keep your patience and remain calm and unexcited.

If the poisoning started thorough skin, the chemical should be identified, the clothing of the patient should be changed, wrist watch etc. should also be removed. The effected areas should be washed thoroughly with clean water for 10/15 minutes so that all traces of the poisonous chemical can be removed. If the skin is effected externally, oil, butter, ghee, sodium bicarbonate etc. should not be applied without doctor's advise.

If the poison has entered the body by way of mouth, the patient should be make to drink several glasses of drinking water (or milk). If the patient is not fully conscious do not try to feed anything. The patient should try to vomit (by putting the finger in throat). If necessary mild saline water (one tablespoonful salt in one glass of water) can be used. If the poisoning is caused by kerosene, diesel or any strong acid or alkaline material or if the patient is unconscious, no attempt should be made to cause vomiting. In other cases attempts to cause vomiting should be continued till the entire poison is removed or stomach is emptied. If the poison can be identified the appropriate antidote should be applied. In absence of proper identification 15 gms or two heaped tablespoonful of universal antidote can be given with a glass of slightly hot milk. Under no circumstances, any oily substance or drinks like brandy etc. should be given without doctor's advise. If possible sample of the vomit should be collected.

In case of patient, poisoned by a respiratory toxicant, attempt should be made to identify the chemical. If it is chlorine, hydrogen cyanide, hydrogen sulphide or any such dangerously poisonous gas, gas-mask should be used for rescue operations. In case mask is not available breath should be hold to avoid poisonous effect to maximum possible limit. It should be remembered that one inhalation in a saturated poisonous atmosphere is enough for making one unconscious.

One should enter closed room or atmosphere only after taking full precautions. Patient should be removed to fresh air as early as possible ; and if necessary, arrangements should be made for artificial respiration which should be continued till the doctor arrives, or doctor advises to stop the same.

If the poisonous chemical has entered the eyes, the same should be removed by rinsing with enough water (preferably slightly warm). Washing should be continued for 10/15 minutes keeping the eyes open, so that all the chemical is removed.

Symptoms of several poisonous ingredients

Chlorinated hydrocarbons : (examples : Aldrin, Chlordane, DDT, Dieldrin, BHC, Lindane etc.) Nervous over-excitement, twitching of eyelids, muscle tremor, symptoms of paralysis, headache, nausea, vomiting, dizziness etc.

Phosphorus compounds : (examples : White phosphorus, Dimpylet (Diazinon), Zinc phosphite, Dicapthon etc.) Breathing difficulty, headache coupled with convulsive muscle contractions on the breast and pupil contraction. These may be accompanied with nausea, vomiting, salivation, diarrhea, muscle convulsions, paralysis of heart activity etc.

Organic mercury compounds : (examples : Mercurous chloride, Mercuric chloride etc.) Burning feeling in mouth, throat and beneath the breast bone, strong salivation. heavy collapse, dropping blood pressure, increasing pulse frequency, diarrhea, unrest, disordered speech, delirium etc.

Arsenic compounds : (examples : Arsenic trioxide, Cupric arsenite, Calcium arsenate etc.) Mouth and throat corrosion, whitening of the skin, thirst sensation, unrest, perspiration, high fever, dizziness, nausea, vomiting, dropping blood pressure and increasing heart frequency, dark green coloured urine etc.

Several types of poisons, their preventives and antidotes

Acids : External measures—The first-aid procedures mentioned earlier should be followed. Internal measures—the patient should try to vomit. Sodium carbonate or bicarbonate should not be used, instead adequate quantity of milk of magnesia or aluminium hydroxide gel should be used. Lastly mixture of milk and egg albumin in water should be given to the patient.

Arsenic compounds : Attempt to initiate vomiting should be done by giving slightly warm saline water to the patient. After vomiting, two teaspoonful of milk of magnesia mixed in water should be given which will be followed by milk, butter with the permission of the doctor. After this feeding, application of ferric hydroxide acts as a very effective antidote.

Methanol or Methyl alcohol : After first-aids one glass of water mixed with two teaspoonful of sodium bicarbonate should be given to the patient.

Alkalies or Caustic : After providing first-aids discussed earlier, arrangements should be made to stimulate vomiting. Enough quantity of lime juice mixed with water or dilute solution of 1% acetic acid or 1% dilute mixture of citric acid or 1 part of vinegar with 4 parts of water should be applied. After this, a mixture of egg albumin in water or milk should be given to the patient for drinking.

Barium compound : Two tablespoonful of magnesium sulphate mixed with water should be given immediately to drink. Then mixture of egg albumin in milk or water should be given.

Cyanide or similar other compounds : Being very poisonous gas, always gas-mask should be used while using or doing rescue operations. Immediate medical attention should be provided. as the poison is very fast acting chemical, slightest delay may lead to such a situation when nothing can be done to improve the condition of the patient. The patient should be removed to open air immediately. All infected articles of clothing must be removed ·and the patient should be given fresh clothing. Attempts should be made to maintain normal body temperature i. e., care should be taken to see that the patient do not collapse. In case of breathing difficulties, artificial respiration should be carried out. Small quantity of amile nitrite should be taken on handkerchief and the same should be placed for several time (5/6 times) before patient's nose for a short spell (for about 15 seconds). This chemical is heart stimulant. If the patient is conscious, attempts should be made to initiate vomiting by administering slightly warm saline water.

Formaldehyde and similar other compounds : In case the patient have taken any such chemical, a glass of milk or water mixed with one tablespoonful of ammonium acetate should be given to drink. Adequate amount of slightly warm saline water should be given to initiate vomiting. After vomiting, raw egg and milk should be given to drink.

Lead compounds : Immediately a mixture of 15 to 30 gms of magnesium or sodium sulphate should be given. The patient should be given egg albumin mixed in milk or water to drink.

Nicotine and similar other alkaloids : In case of poisoning by these chemicals the effective antidote is a mixture of 1:1000 (i. e., 0·01% strength) potassium permanganate in water. The use of universal antidote is also very effective.

Phosphorus compounds: If such chemical enters the body through skin, the effected areas should be washed with adequate water first, and then with 3% copper sulphate solution, so that all traces of phosphorus can be removed. With permission of the doctor a 1 mg atropine tablet can be given to the patient. In case of excessive breathing difficulties and weakness of heart, adequate care should be taken before administering atropin. In case of necessity oxygen and heart stimulant can be given with doctors permission. Arrangements should be made to keep respiratory track clean. If the poisoning started due to swallowing, then arrangement should be made to wash the stomach with slightly warm 5% sodium bicarbonate solution.

Zinc compounds : In addition to first-aid 28 5 gms of milk of magnesia or white parts of 2/3 eggs (albumin) mixed with water should be given to drink.

Chlorinated hydrocarbons : Attempts should be made to initiate vomiting by drinking slightly warm saline water. In cases of poisoning due to DDT etc., milk or castor oil should never be given to drink.

Mercury compounds : Adequate milk and protein-rich foods (e. g., six raw eggs) and drinks should be given to the patient. 2 to 5% sodium bicarbonate should be given with the doctor's approval. Sodium sulphate can be applied to the stomach with help of tube under doctor's advice and supervision. If necessary, arrangements should be made for stomach wash.

List of materials to be stored to face emergency due to accidental poisoning

1) Universal antidote which is prepared with the following chemicals : Activated charcoal 2 parts ; Magnesium oxide (Milk of magnesia) 1 part ; and Strong tea liquor (tannic acid) 1 part.

This mixture is quite effective against most poisoning cases caused due to various poisonous chemicals. In cases, where it is not possible to identify the poisonous chemical immediately, use of this mixture becomes essential to reduce the poisonous effects.

2) Good quality (edible) Ferric hydroxide, Milk of magnesia, Sodium bicarbonate, Sodium carbonate, Sodium sulphate, Potassium parmanganate, Aluminium hydroxide, Magnesium sulphate, Ammonium acetate, common salt.

3) 1% Acetic acid, 1% Citric acid.
4) Amile nitrite 0.3 ml pearl.
5) 3% Copper sulphate mixture.
6) 5% Sodium bicarbonate mixture.
7) 5% Sodium bicromate.
8) Mixture of 1 part vinegar and 2 parts of water.
9) Atropine sulphate 0.6 mg tablets.
10) Activated charcoal.
11) 4% Tannic acid mixture.
12) 1% Boric acid mixture ; etc.

CONSERVATION OF OIL PAINTINGS AND WATER COLOUR PAINTINGS

Many libraries which have in their collection ancient materials, often have art objects also, which consist of mainly the oil and water-colour paintings. In comprehensive discussion of conservation, naturally the question about these also comes up, though preservation of these items require specialized training and knowledge. But the librarians must have a bird's eye view of the total position to get rid of the wrong conceptions, which are very common and may cause immense damage to the collection.

Those libraries which are attached to museums, the conservation problems of art materials are the job looked over by the museum personnel. But in other case where it is not attached to any such organization and the art collection is very small, the job of conservation of paintings are to be sholdered by the librarian. This type of materials are quite different from all other library materials and at the time of training in library science, various type of problems related to objects like paintings are never discussed. Therefore, naturally, when in the practical field one come across such problems, he finds it very difficult to solve them. This situation necessitate a brief discussion on this matter here.

Let us first examine the methods of conservation of these materials which are in practice and try to evaluate them to find out their pros and cons. All paintings, whether oil or water-colour, when left hanging in frames are affected by dust and dirt in natural course. Like other library materials, these also require proper dusting and cleaning. Inspite of all these, it will be found that with passage of time, it gradually becomes discoloured ; in case of oil-paintings often paints starts flaking off or bears the sign of fungi attack.

Occasionally it is found that paintings are either washed in water or cleaned with the help of water-soaked cotton or soft cloth. But this should not be done, as it may cause serious damages, though it may appear that most of the dust is removed by this process. Particularly in case of water-colour paintings the colour can be washed out completely if washed with enough water. In case of oil-painting, water can ooze in the medium—the canvas, paper, etc., through fine cracks on the paints and damage it in the form of swelling/expansion or contraction of the medium, which may cause flaking of the paints and induce fungi attack. For similar reasons, it is more dangerous to use soap or detergent water. Some time it is advised to cut a potato or onion into halves and clean the picture by rubbing with the cut out edge. But this is also a dangerous proposition, as the vegetable juice may enter, through the cracks and may cause serious damage. [Kelly, Francis. Art restoration. Newton Abbot, David & Charles, 1971. p. 162-3].

The paints which are used in oil-painting gradually changes its colour with the age and becomes quite hard within 70-75 years, when it cannot be dissolved in mild chemical solvents. But prior to that stage, damage through use of solvent is much more high and therefore, careful steps should be taken at the time of cleaning etc., with the help of chemicals.

It is not possible to indicate one single formula for cleaning or restoration of paintings, as each individual painting have its own problems and their solutions are different. Even in case of one and same painting the problem may differ from one region to other and so their solutions too. Therefore, to find a solution to various problems connected with conservation/restoration of painting, one must have adequate patience, eagerness to understand the problems and self-confidence based on experience. Each painter have his own choice of paints and system of working and on all these factors depend the conservation and restoration policies.

Almost all the oil paintings are coated with one types of varnish or the other. With passage of time this varnish first turn yellowish and then to light brownish, losing its transparent character, which adversely affect outer appearance of the painting. In such cases proper cleaning of the picture means full removal of the varnish layer, which is one of the main problems, one have to face in the process of conservation of painting. The solvent that is to be used for this purpose depends upon the varnish that was used on the picture. In cases where the varnish has become too brittle, it is possible to remove the same with the help of soft brush. In case of other pictures, effect of various solvents are to be tested by putting them on one edge of the picture, which will remain covered under the frames and by that way only the appropriate solvent can be selected. If a very weak solvent is selected the varnish will be removed very slowly, which may prove damaging to the picture. Due to application for a long period, it may soften and penetrate the layer of varnish and cause damage to the picture. In case of solvents of medium strength, possibility of problem of this nature become much more limited. When trying out solvents, areas with lighter colour should be selected, as it is easier to follow the reaction more closely in that area. In case of areas with darker paints mainly black, brown, etc., it becomes difficult to determine if some paints are removed along with dust and dirt.

Though it is already said that it is not possible to dictate one and single system for restoration of pictures, but in this process it is essential to give adequate attention to several aspects. In selection of appropriate solvent and then to proceed with the actual cleaning operation the following steps becomes very important.

1. The picture should be opened from the frame first and placed on a table.

2. Whichever solvent is selected, it is first to be noted whether it is homogenous or not ; if not, the mixture should be properly shaken to make it homogenous before use.

3. Solvent should be taken on clean cotton in small quantity.

4. The cotton soaked in solvent should be rubbed very lightly over selected portion of the picture with circular motion of hand ; it should be noted that movement of hand should not stop on any part and the solvent should be spread on all parts equally.

5. Work should be continued with new cotton replacing the old one, when it becomes slightly dirty, till the expected result is achieved. It should be remembered that work should be done with utmost patience and with very light pressure, otherwise the oily or similar other component of solvent will enter the layer of the paint and damage the same.

6. After each application, it should be checked, if any portion of the paint is visible on the cotton piece ; work should be stopped immediately, if any trace of paint is noticed on the cotton.

7. When it is noticed that no further dirt is removed, application of solvent should be stopped and the picture should be wiped out with clean dry cotton to remove any trace of solvent that may remain on it. It is worth mentioning here that, so long varnish is present on the painting, a slippery feeling can be felt while moving the cotton on it, but after the varnish is fully removed, the feeling becomes rough.

8. After the full removal of varnish coating, the surface of the picture becomes slightly soft and sticky. To remove that condition it should be allowed to remain in a room free

from dust and dirt so that the surface can be dried up thoroughly.

9. Fresh layer of varnish should be applied on it.

10. When completely dried, it should be framed back to its original condition.

Normally spirit is used to make the solvent dilute or more fluid. Ammonia, cellosolve, ethyl alcohol, methyl alcohol, toluene, oil of turpentine, xylene, etc., are the other main solvents used. But the most used solvents are acetone diluted in spirit and acetopropane alcohol. Though spirit do not have any reaction on old varnish, in case of fresh varnish it can easily soften the same. As most of the solvents are harmful to human skin, it is advisable to use gloves at the time of working with such chemicals. There should be arrangement for proper and adequate ventilation in the room or laboratory, otherwise the solvent vapours in the room may cause harmful effects on the workers.

The varnishes those are used on paintings can be broadly divided in two groups—one is oil based and the other is spirit based. In case of oil based varnishes hard type of resins, e. g., copal, amber etc., are used. In spirit based varnishes usually comparatively softer resins e. g., sandarac or mastic are used, which are soluble in alcohol or turpentine. Hard resins are normally mixed with oil at high temperature. This varnish take comparatively longer time to dry up due to slow evaporation of oil, but are more durable and permanent and can stand the reaction of solvents of medium strength. Spirit based varnishes get brittle easily and can be removed with comparative ease. This type of varnish dries up quickly after application due to evaporation of spirit.

Fungi attack can damage and even destroy the canvas, paper or similar other media. In damp and humid atmosphere the attack becomes more intense and spread more quickly. Fungicides should be used immediately, when the attack is noticed, as an early action can save the medium, e. g., canvas from decay. 5% diluted mixture of formaldehyde, if applied with soft brush, can give good result. In case where the area of attack is big enough, it will be convenient to use sprayer instead of brush. It will be better to have wooden or similar other protecting sheet fitted on the back of the picture/painting, as it will not only protect against humidity but also chances of damages due to pressure, scratch with sharp edge, etc. will be reduced.

After removal of discoloured varnishes, it will be necessary in most cases, to have fresh varnish coating Though often it is said that painting can be better protected by covering with glass sheet to protect it from touch of observers, adverse weather etc; but from the standpoint of artistic ethics, it can be said that varnish covering is far better arrangement, as in case of glass covering, it is not possible to enjoy the painting properly due to reflection and allied problems, e. g., due to presence of glass, the colour of paint becomes distorted or changed etc.

While covering the painting with new varnish it should be remembered that other than protecting function, it should noway stand on the way of enjoying the real beauty of the painting. It should be adequately hard, durable, but removable with comparatively mild solvent. It should not be changed easily, e. g., get brittle, chipped off or swells up, reacting with adverse surrounding. It should be perfectly colourless and transparent and should improve the quality of the painting instead of damaging it. It is difficult to name one single varnish, which have all these qualities as it is our experience that the varnish which is easily removable is not very durable ; again most of the varnishes turn yellowish with passage of time. Still artificial resin MS_2A or Keytone N can be picked up as one of the most suitable varnish. Excepting these many experts are of the opinion that polyvinyl acetate is also another excellent varnish, though it have one major drawback in the form that at the time of removal it is necessary to use fairly strong chemical solvent.

Water-colour painting are more vulnerable to damage in comparison to oil-painting. A water-colour painting which is 25-30 years old, is not readily damaged by water. In case of any stain on such painting Chloramine T should be used for rectification. The method of its application is already discussed in chapter dealing on preservation of manuscripts. In case of very weak paper, it should be placed on a clean blotting paper (painting side in contact with the blotting paper) and Chloramine T mixture should be sprayed to remove the stain. As the chemical acts very slowly, this method requires enough patience.

Normally water-colour painting is done on paper, specially on handmade paper. Both paper and paints used in water-colour painting readily absorbs moisture from atmosphere, which can ultimately result in fungi attack. To avoid this type of damage, care should be taken for keeping these away from moisture as far as possible. To achieve this it is preferable to have it glass mounted, which help to keep it in unaffected condition for much longer period. Care should be taken so that these paintings are not exposed to sunlight or other types of strong artificial light, as long exposure to such condition will result in fading or changing of most colours, which will result in deterioration of quality of the original appeal of the painting.

In case of paintings on paper with help of ink, it is often seen that paper is seriously damaged by acidity of ink. In case of several paintings of Rabindranath Tagore, similar problems have appeared and some of them are restored and repaired with active help of National Archives of India at New Delhi. We have already discussed about various aspects of removal of acidity caused by ink on paper, earlier.

It may be worth mentioning here that restoration of painting is a technical and quite difficult job which requires specialized training ; therefore, in case of costly and important paintings, before any attempt of restoration work is done, specialist advice from the restorers of notable museums of the region (e. g., in eastern India from Indian National Museum or Victorial Memorial Hall) may be obtained. If necessary, help and advice may also be taken from National Archives of India, New Delhi.

SOME SPECIALIZED COLLECTIONS IN MODERN LIBRARIES : THEIR CONSERVATION PROBLEMS AND SOLUTIONS

In modern library collections, we find certain materials which were not found in any library even a few decades ago, when the main components of library collection were books, paper, leather materials, barks, cloth, palm leaves, etc. The new items that we find in modern libraries are gramophone records, photographs, microfilms, microcards microfiche, cinema films, audio tapes, video tapes, computer tapes, etc., which are all products of new' scientific progress. Though most of the library users find its use slightly inconvenient at the initial stage in comparison to the conventional library materials, but we cannot deny its utility when we consider the present situation of information explosion and other prevailing circumstances. The use of these are growing and will go on growing in future also. As an example, we can cite the case of microfilm—which is extensively used to solve storage space problem as well as limit cost of preservation of newspaper collections ; and its usage in this sphere is accepted throughout the world. These new-entrants among the library collections have varied conservation problems and the solutions are also different. To understand these, we have to take each of these materials separately and study their composition, usage, problems as well as probable solutions.

Gramophone Records

The technique of recording the sound wave was invented towards the end of last century, but commercially it came in market only in the last decade of last century. It invaded the library only in the early part of this century ; by that time there was lot of improvements also in the field of recording. We will not find many early recordings in normal libraries other than record archives. The records, which we find normally in a library, are either 78 r. p. m. or 33.5 r. p. m. records. The materials of early records were comparatively brittle ; but later unbreakable materials were used to manufacture records. This change of components have reduced the conservation problems to a great extent.

It can be generally said that gramophone records are damaged by environmental elements, e. g., moisture, excessive heat, pollution (which can create chemical reactions) and to some extent growth of fungi. Other than these, specially for the records of earlier periods (when they were not manufactured with unbreakable materials) strong pressure or sudden crash with other hard materials may cause serious damage.

If humidity can be controlled to 50% or lower, reduction in the rate of deterioration of gramophone records can be achieved to a great extent. If a record is made up of high quality shellac or vinyl, it do not deteriorate due to aging; but records made up of other comparatively less durable materials can be damaged easily—some by heat or humidity and others due to reactions with polluted air, which make the surface brittle affecting the sound tracks extensively. Particularly the record manufactured of cellulose acetate, cellulose nitrate are very unstable and can be damaged easily and ultimately destroyed by light, heat, humidity, etc.

Storing procedure is extremely important in the field of conservation of gramophone records. Records should always be stored in a standing position in specially designed racks having supports after 10 to 15 cm (4″ to 6″ inches) apart. If they are not kept in standing position, records can easily bend due to the effect of heat and humidity, effecting the sound recorded. As both vinyl and shellac are very strong materials the side on which the record is standing can be changed once in 7 or 10 years. Controlled heat and humidity is essential for long term conservation of these materials.

Audio Tape Record

The method of recording with the help of magnetism was invented in 1899, but successful modern tape recording was first done in 1936. It became a popular medium only after the second world war. Tape recording was first done on paper and then on cellulose acetate and nowadays on a special type of polyester material.

The conservation problems depend on the composition on which the recording is made, its thickness etc. In case of high quality tapes, it is possible to have recording on multi-track on the same tape. But the most popular and most used form of tape recording is cassette tape, where the recording is made on narrow tape of thin medium and can be recorded as well as played on comparatively simple machine.

The recording done on polyester medium is much more stable. The tape remains rolled round a reel or spool under a definite tension. If it is not properly rolled, the sound stored in it will get damaged. When a tape is rewinded or run 'fast forward' it gets rolled at a higher tension and remains in tighter condition, which is damaging from the conservation standpoint. Therefore, it should be remembered that tapes should not be stored after use in a higher tension. After use it should not be rewind. As the recording done on this with the help of magnetism, it is very sensitive to fluctuation of temperature and humidity. In storage area the arrangement should be made in such a way that fluctuation do no cross the limit of 2° C or 10% in case of temperature and humidity respectively. Care should be taken in another aspect also—in the storage area, there should not be any strong magnetic field and there should not be any electric wire carrying high voltage electricity or transformer or electric motor, as their presence may cause serious damage to the sound quality of the tapes.

As in case of cassette tape the medium used is very thin, the durability is also limited and the tapes can easily be torn and recored sound can get distorted, but it is still popular due to easy usability. From the conservation standpoint it is necessary to re-record or transfer the recorded matter from cassette tapes to reel tapes.

Dust and dirt are damaging for all types of tape recordings. So these should be stored away from dirt and dust and be used in a neat machine and clean atmosphere, preferably in airconditioned room. The conservation of these recordings are complicated due to its complex technology. Its conservation also need proper care to see that the sound record is not distorted or damaged in any form with passage of time. In some cases it becomes essential to have it re-recorded in appropriate medium. As sound can be distorted easily, extreme care is necessary at every step. Due to modern advanced technologies, it is possible to eliminate unwanted sounds from a tape but no such attempt should be made for music or any similar recordings, as it may damage the main musical sound.

It is possible to prevent deterioration and conserve the recording in its original form for a very long time, if they are stored in appropriate temperature and humidity in a pollution-free atmosphere and proper storage condition (preferably airconditioned) in the library. It is also important to ensure its proper use in high quality machine with adequate care. Generally rare and valuable recordings should not be allowed to be used by general public. In case of demand, copy should be made and that can be given to general users, to avoid damage to original one.

Photograph

By photograph, here we mean black and white, colour-prints, negatives, slides, etc. everything connected with photographic reproduction Conservation of photograph is very complex, mainly due to two reasons—firstly, it is a very new addition in the library collection and secondly, the material and the chemicals used in this are varied and difference of one from the other is considerable. Actually photograph is nothing but transferring an image utilizing photochemical reaction on the photosensitive layer placed on paper, glass, metal, plastic or any other suitable material. In case of black and white print silver compound and in case of colour-prints various chemical dyes are used.

The main reason behind deterioration of photographs are chemical reactions, as most of the materials used in production of negatives, prints etc., have some deteriorating factor planted in them from the time of its preparation It may be in the form of instability of the chemicals used, presence of traces of damaging chemicals used in developing or fixing the print, etc. Other than these, chemical reactions with the atmospheric pollutants, improper temperature and humidity in the storage area etc., are also responsible for deterioration, as a result of which prints may get hazy, colours may change, sometime chemical layers may chip off.

Negative : During the first three decades of this century, the base of film negatives (on which the photosensitive chemical is applied) were made of cellulose nitrate. Though the stability of cellulose nitrate varies from one manufacturer to the other, it can be generally said that this is a very unstable medium and highly combustible (combustibility increases with its age). It loses its colour and becomes brittle with deterioration. Sometime the gelatine mixed chemical layer on the base becomes soft and sticky. At high temperature and high humidity nitric acid is formed with the deterioration of cellulose nitrate. High combustibility and formation of nitric acid endangers the stability of the materials stored in its vicinity.

Since 1935, use of cellulose acetate, in place of cellulose nitrate, started which is much more stable. But in case of its earlier use there were problems like shrinking of negatives, chipping off of the chemical layers, etc. It can also get damaged at high temperature. In later period all these problems are reduced through the use of better quality of cellulose acetate.

Since 1965, use of polyester has started in place of cellulose acetate, which is much more strong and durable substance and not readily damaged by high temperature.

Positive : The durability of positive depends mainly on the paper on which the print is made. This fact came to the notice at a very early stage of development of photography and as a result use of high quality paper for making prints started, eliminating the chances of inbuilt deteriorating factors in case of prints. Therefore, most of the damages to prints are done by the environmental conditions. The print which is made with adequate care and preserved in appropriate storage condition, will remain unaffected and in good condition for a very long period.

Recently a new type of resin-coated photographic paper for making prints are available in the market on commercial basis. Its durability and other conditions as far as conservation is concerned, is not known and so far not much works are done on this new medium and for that reason extensive care should be taken when preserving these type of materials.

Generally it is noticed that traces of developer remains at the edge of the prints. It is, therefore, useful to slightly trim the edges of the prints before preservation. At the time of storing, each print should be separated from the other with the help of high quality paper, so that defect of a print cannot damage the other.

In case of both positive and negative, if the processing is not done properly, the stability of the product will definitely be affected. But this problem can easily be eliminated through carefully and properly following the manufacturers' directions in respect of the strength of the chemical used. Proper washing should be done to eliminate possibility of traces of chemicals used remaining on the product. This can be achieved through use of pure water and repeated change of water during the washing process. Quality control at every stage is essential for getting the best result.

Polluted air makes prints hazy and cause various stains on print ; low quality paper and inferior gelatine coating help quick deterioration.

The problem of photograph preservation are also caused by the faulty storage condition. Cheap plywood, cardboard or paper damage the photograph preservation efforts, as they may contain various chemicals including acids which may cause stains and may result in brittleness. The paper envelop, cellulose acetate casings or plastic reel may also contain damaging chemicals unless they are selected with proper care. The unstable adhesive, e. g., rubber solution, adhesive tapes, several types of ink used for marking have also deteriorating effect on photographs. Print on papers get more readily damaged in comparison to films as paper absorbs moisture and chemicals from air more easily and in general, these are handled more frequently than the negative films.

It is a common experience that the colours of colour-prints fade out within 10-12 years. The reasons behind these are some very complicated chemical reactions, which occur at a faster speed in higher temperature and humidity. If the polluted air and enough light (both normal as well as ultra-violet) are available, the situation becomes extremely suitable for fastest deterioration. But the effect on different colour are different. Various experiments, on the problems of colour-prints and their solutions, are going on in foreign countries.

The Kodak Company have devised a new process for producing colour-prints, in which different black and white negatives are prepared from the colour-print, and with the help of special photographic medium dye inhibition of tri-colour exposure on to photographic materials, prints are made. Prints made in this process are more stable. This process is known as Dye-transfer process and is very costly.

Till now the most effective method that is devised to preserve photographs is to keep them in complete darkness at a very low temperature. In this connection a table suggested by Kodak Company may be mentioned

Rate of Change of Colour (**at 40% humidity**)

Temperature (Degree) C	Relative Rate of fading	Relative preservation period (Yrs)
30	2	·5
19	·5	2
7	1/10	10
−10	1/100	100
−26	1/1000	1000

From the above table it is apparent that the rate of deterioration of a print preserved at 30°C will be four times faster than a print kept at 19°C.

Apart from the chemical damages of which we have discussed so far, some damages may be caused by insects, fungi, etc. Due to careless handling, photographs may be scratched. In those cases, where colour is not very important, it is wise to have black and white prints for preservation as these are comparatively stable.

Photographs and photographic materials should be preserved in complete darkness at 30% humidity and 20° to 21°C. Though a lower temperature is much more suitable for conservation, it is not possible to make such arrangements in smaller library considering high costs involved in it. Another precaution can be taken, if possible, to keep the original print away from general use and give a copy to the regular user for their use. To control humidity, where air-conditioning system is not available, chemical or electric or electronic dehumidifiers can be used. But care should be taken at the time of selecting the dehumidifier to ensure that the same do not have any adverse reaction on the materials stored or the environment.

Cinematographic Films

As nowadays the audio-visual system is being increasingly used for education, there is every possibility to find cinematographic films in big and medium sized libraries attached to educational institutions—mainly who are engaged in higher or technical education even in our country. Mostly these are either 16 mm or 8 mm films.

All the problems about which we have discussed in respect of photographic materials and photographs, are also valid for the cinematographic films. In addition to those, there is one more important problem in this case, which is caused due to the stress and tension that occurs at the time of projecting films.

It should be remembered that so far as colour films are concerned in the early period i.e., from 1928 to 1952, the films that were produced in a process which was costly but the products were of much more durable quality. But in 1951 the Eastman Kodak Company introduced a new colour film processing system, which is comparatively easier and cheaper but the end-product is not very durable, and the colour starts fading within five years.

It is not possible for a library to bear the expenditure of huge amount for preservation of cinematographic films. Yet it is worth to note (even though it will not be possible for any Indian library to follow it due to cost factors) that now in foreign countries, they have devised a method in which parts of different colour are separated in separate reels and preserved separately. In this way it is possible to preserve the colours more perfectly. To preserve a full length film using this method will cost something between 2 to 4 lakhs of rupees. Even in those countries only very valuable, rare and important films are preserved through this method, owing to high expenditure involved.

Generally it can be said that 30% humidity and a temperature of about 21°C can be very effective in preserving cinematographic films.

Microfilm, Microfiche, Microcards etc.

Microfilm started to invade the library since 1930. The main reasons for this incidence are the space economy, low cost and easy accessibility. Gradually it made its own place in all big libraries. Nowadays use of microfilm in the field of preservation of old issues of newspapers and periodicals is extensive and universally accepted practice. These films may be either 16 mm or 36 mm in width—though the later is more popular. Generally each film roll held film of 30 metres (i. e., about 100 ft.) lenght. These films may be of three types : silver halide, diazo and vesicular. Actually these names indicate the constituents of the film and it should be remembered that the durability, causes of deterioration and techniques to be followed for conservation are dependent mainly on the constituents of films.

Silver halide films are identically similar to that of photographic negative of black and white pictures. In it gelatinous silver compound is found in the form of an emulsion on one side of a thin transparent plastic or cellulose acetate or polyester sheet. When the film is exposed to natural light through a camera, the negative is formed due to photo-chemical reactions. As silver halide is photo-sensitive and comparatively easy to use and handle, this type of film is almost universally used for preparation of negative films. It should be developed in complete darkness in a controlled condition. Developing is followed by another chemical process known as fixing. Finally the film is thoroughly washed in clear running water for some time to remove the traces of chemicals used for developing and fixing, e.g., sodium thiosulphate, which is generally known as hypo, as any trace of this, that may be left on the finished product, may become the main source of deterioration in future.

In case of Diazo film, the emulsion of diazonium salt is used in place of silver halide, on cellulose acetate or polyester film. As this chemical is not sensitive to normal light, photographs can be taken only using ultra-violet rays. Ammonia vapour is used for developing and fixing. Due to chemical reactions caused by ultra-violet rays, ammonia vapours can not produce dark impressions on the parts where the reactions with ultra-violet rays have occurred and thus image is produced. But the process is slow and therefore, this film cannot be used in cameras. As cost of this film is very low, it is normally used for copy services and for distribution purposes. If a diazo copy is made from a silver halide negative the copy will loose only 4% details, which is very nominal in case of ordinary prints. The quality of a diazo print depends on the quality of the negative from which it is prepared and the amount of care taken for preparation of the copy. Normally the diazo prints are made by keeping the silver halide negative and the diazo film one above the other and then passing ultra-violet rays through the same, i. e., by using the contact printing technique.

In case of vesicular film diazonium compound is spread over the polymer film. When ultra-violet rays act with the compound, it emits nitrogen gas which enters the polymer film. When heat is applied to develop the film, this nitrogen gas takes the form of small bubbles within the polymer which becomes soft due to application of heat. Then high intensity ultra-violet rays are again passed through the film to fix the image. Therefore, here photochemical reaction is not used for developing image, as in the cases of both silver halide and diazo films. As in this process no liquid chemical or water is used, this is a very easy and cheap process and extensively used to produce copy for distribution and copying services.

Deterioration in case of microfilms occurs mainly in three ways : (a) due to scratch, chipping off of the chemical emulsion layer, and due to damage or deterioration of the original sheet medium which is either cellulose acetate or polymer. Damage or deterioration may be of two types, e.g., details of the image may be lost or background or colour of the print can be gradually changed reducing the contrasts.

Minor faults at the time of preparation of microfilms may become the cause of major conservation problems. But librarian or library workers can do very little in this respect, as in most cases the microfilms are purchased from various commercial organizations. (There are some very big libraries who have their own microfilming unit). As the storing of films within the library is under the control of the librarian, he can take suitable steps to delay, if not completely eliminate the future possibility of deterioration by taking appropriate measures. At this stage he should also consider the harmful effects of possible factors present in the storage area and its environment, so that they cannot cause fresh damages in future.

Various films get damaged in different ways due to faulty storage procedure ; e.g., the image on diazo film gets faded if kept under strong light. The most common film damages are caused by leaving the films on the reader after it is used. In case of silver halide films, this may lead to absorption of moisture by the films and in 60% or above humidity fungi may grow on gelatine layer and spread very fast ; it can also be damaged due to long exposure to heat. The other two types of films are not affected by humidity. If exposed to comparatively high temperature for a short period, both silver halide and diazo films are not damaged. But vesicular film gets completely destroyed if exposed to 80° C for a short period.

All types of plastic get damaged due to aging, but such deterioration is accelerated by higher temperature. The cellulose acetate sheet becomes sticky in hot and humid atmosphere and the emulsion chips out and falls away from the sheet. Though polyester is not affected by humidity, it gets damaged by high temperature.

If not properly stored, the pollutant gases may cause serious damage to the base of the film, as well as the emulsion part. Dust and dirt may cause scratches. For silver halide films sulphur dioxide, peroxide, ozone, ammonia, etc., are very damaging There are some type of damages in case of microfilms, which are known as "Rodex Blemishes", on which there were extensive studies. As a result some causes for this problem are identified. In brief, it can be said that if the microfilms are stored in boxes made up of low grade paper or cardboard, then the peroxide emitted by those materials and pollutant gases of the atmosphere react with the traces of chemicals left on the film from the time of its manufacture, produce rodex blemishes. At present 0·2 gm potassium iodide is mixed with each litre of fixer at the time of fixing films to prevent the possibility of future redox blemishes. Careful selection of good quality storing materials, avoidance of using rubber bands on films (particularly silver halide ones) can help us in preventing deterioration of films.

All films should be handled with extreme care. Finger print on silver halide film is very damaging, as on this print the trace of sweat or presence of other chemical may cause damage to the emulsion. Films should not be rolled very tightly and always be kept away from dust, dirt, heat and humidity.

Experts are of the opinion that silver halide films are most stable and durable, if properly stored and preserved. But in the libraries where the films are often used/handled by general users, the use of vesicular film is mostly preferred due to its ability to stand comparatively more rough handling. Both the diazo and vesicular films are devised after the second world war, but due to its low cost and ability to bear rough handling, its uses became popular in those cases where high quality print is not essential.

Other than precaution and care in handling of which we have mentioned, another very important point should be taken care of, which is atmosphere in the storage area. It should have 30% humidity and temperature of 21° C (both these should remain steady throughout the year). The room where the films will be stored should be specially made fire resistant. Care should be taken to avoid strong light or sun ray entering the store room.

Microfiche are transparent film of 14·3 cm × 10.2 cm (6″ × 4″) size on the top portion of which index is printed in a directly readable type and in the other portion, which is generally divided in 60 or 98 equal sections, the matter is printed in a highly reduced form. In each such section normally one page is printed by making the image 24 times reduced. This is readable by using special reader in which the reflected image is enlarged into a readable size.

Comfiche (Computer output on Microfiche) is exactly similar to that of microfiche but here the card have 270 sections instead of 98 and the image printed on it is in more reduced from. Special reader is necessary for deciphering the prints.

Ultrafiche is also similar to microfiche but here in a single fiche 3280 pages of a book of 21.5 cms × 27·5 cms (8.5″ × 11″) size can be printed. From this it is evident that the image is printed in very reduced form and therefore extreme care should be taken to use it, as even a slight scratch will cause serious damage in the print. Special type of reader of very high enlargement capacity is necessary to read this.

All these Microfiche, Comfiche, Ultrafiche, etc. are made up of silver halide film and therefore, same care and preservation methods should be applied for proper conservation, which are suggested for silver halide films.

Video Tape

Video tape is prepared by application of magnetism as in case of audio tapes. From very beginning, the commercial manufacturers have given too much attention to low cost, mass production and easy usability and neglected the durability aspect of the video tapes. Often it is found that due to its easy useability, such records are made on it, which are important and should be preserved. But due to its manufacturing processes, it is basically a very shortliving medium. From the standpoint of preservation, chemical and physical nature of the base, its tensile strength, thickness etc., are vital.

All video tapes loose the recorded information on repeated use, as the base gradually lose the magnetic power. Apart from this with each run some amount of dirt and dusts invades the tape from the playing head which damages the tape due to abrasion during the next use. Only way to avoid or reduce this problem is to use video tapes in a clean air-conditioned atmosphere, proper maintenance of equipments, careful handling and proper care for storing. Like audio tape, this also should never be kept in a tight rewind condition.

It can be generally said that tapes manufactured after 1980 is of better quality and more durable. The video tapes are very sensitive to fluctuation of humidity and temperature.

Therefore, it should be ensured that temperature should not fluctuate more than 2°C and humidity by 10% in the storage area, where it is preferred to have good air-conditioning. No electric wire carrying high voltage electricity or electric motor or transformer should be allowed to remain near the storage area.

Computer Tape

Computer tapes can be damaged in the same way as the audio and video tapes. In computer tape plastic medium is used as the base and that makes it less durable. Even if it is kept in ideal conditions it will not last more than 15 to 20 years. The durability of computer tapes varies with its manufacturer. Control of humidity is a major factor in the preservation of these. It is heartening to note that recently the manufacturers are taking some serious steps to improve its durability Normally this type of tapes are used for recording very important and vital information. Therefore, adequate care should be taken to make the storage room fully fire and flood resistant. The most suitable conditions for preservation of temperature and humidity are 21° C (±2° C) and 50% (±10%) dirt, dust as well as pollution free environment. Storage area should be away from high voltage electrical field, and the light should also be controlled. The tapes should be used with adequate care to help preservation effort. Each and every tape should be run atleast once a year which is helpful for healthy preservation. If required, the tapes should be re-recorded to preserve the information from deterioration due to aging.

Use of Reprography in Conservation

In modern library, we often come across many documents which cannot be given to general users for various reasons e.g., brittle condition, rarity or value (as it is irreplacable) etc. But all the collection of a library is for use, in one way or the other, as indicated in one of the five laws of Library science propounded by Dr. S. R. Ranganathan 'Books are for use'—nowadays which is slightly modified to 'Documents are for use'. If we have to obey this directive, then there is only one way by which we can give the rare, extremely brittle documents to the users by utilising the reprographic systems. Reprographic system can be divided in two different parts : (a) Micrography—in which a copy is made in a reduced form, which cannot be used with normal eye and for its decipheration special equipments are necessary to produce magnified image ; (b) Macrography—by which normal readable copies are produced, example of which are xerox copies.

Macrography

Chester Carlson discovered earliest electrographic process in New York in 1937. This process was extensively researched and developed by Schaeffert, Mott and their colleagues, and became a phenomenal success commercially. Generally the library items which are very delicate or for some other reasons cannot be given to the users, are copied by utilising this system, so that the copies can be given to the users to avoid any further damages to the original documents ; at the same time the users request is also honoured. It is used for other purposes also, say for instance, if several scholars or researchers want to use one and same issue of a journal, which the library have only one copy and if it is difficult for any of them to wait for the other to finish his work, then this problem can be solved by making necessary copies and the same is provided to them. In case of a educational institute, when a faculty member instructs his students to go through an article of which only one copy is available in the library, use of macrography can only solve the problem of many students asking for one and the same copy almost at the same time. In this connection, it should be always ascertained that the Copyright Act is not violated in any manner. (We will discuss very briefly about various directives of Copyright Act later in this chapter).

Macrography can be of two types—(a) one is electro-photographic system and the other (b) electrolytic system. Of the two, more popular and most used one is the electro-photographic system which is also known as Xerography. In Greek language 'Xerox' means dry and 'graphs' stand for writing. As no liquid is used in the process, it is known by this name. The process was first introduced commercially in 1950 and during the last few decades there have been lot of changes and improvements in the system, but the main principle underlying the method remains unchanged. In this system either selenium, cadmium sulphide, titanium oxide, or zinc oxide and a special type of resin mixture is commercially used as the photo-conductive material. Of all the chemicals selenium is most used. For a short period cadmium sulphide is also extensively used mainly in Japan (primarily due to its low cost and almost the same quality effect, as that of much costly selenium), but later its use came down sharply when it came to notice that the chemical may have some part to play in causing cancerous diseases. Now even if this chemical is used in drum, the same is covered with such a coating, that its damaging capacity is eliminated altogether.

In xerography, there is a metallic plate, one side of which is coated with a special chemical (generally selenium). The system have got five different stages—(1) charging the plate with statical electricity ; (2) giving exposure to the plate, (3) developing, (4) image transfer, (5) fusing or fixing the image. On charging, the plate becomes light sensitive. At this stage the image of the page for which photocopies are to be made, is reflected on the plate through a special lens arrangement. The printings or markings in black or dark colour in the original document will not reflect light. In the areas where the light falls, will lose the statical electricity which will moves to the metallic plate on the back ; but those areas which are not exposed to light will hold the statical charge. Now on the plate a special black powder known as toner is spread. The statical charge present on it, will draw and hold the toner. The excess toner is removed from the plate and a piece of white paper is placed on it and that is charged with statical electricity by a special method, which transfers the image on the paper. Now the paper is strongly heated so that the toner melts and make a permanent print on the paper. In some modified systems instead of heat application, some type of chemical vapour is used for making the print permanent. In modern automatic machines a drum is used in place of the plate. In a automatic machine, it is possible to have 5 to 100 copies per minute depending on the machine. A good quality drum can give 50,000 to 1,00,000 good copies. As the drum contain a very thin layer of selenium, it should be handled with utmost care otherwise dust, dirt, moisture, finger print or scratches may damage the drum seriously. The black toner (nowadays toners of certain other colour e.g., sepia, brown, blue etc., are also available) produce printing by melting on paper which is quite permanent. The permanence of the copy depends mainly on the quality of the paper used. The modern copiers can make prints on paper of various quality, from fine to very thick. If good rag paper is used, the copy will become very durable and long lasting.

In modern machines we can have copies with very dark printing, of which the darkness can also be controlled and regulated to a certain extent. In earlier times while copying a document having some coloured printing (say red), the copy quality available was usually very faint or sometimes the coloured portions do not appear at all on the print. Similarly, if the documents were on some coloured paper, a very dark beckground appear on the copy. But in modern machines these defects are eliminated by using much more advanced technology.

There are copiers which can give copies of the same size only ; in some other additional facilities for reduction is also available. In most modern machines another facility—arrangement for enlargement is added. In some specialised copiers prints can also be made from microfilms or microfiches with adequate enlargements. The later type of machines are known as printers, where as the others are commonly known as copiers. In most modern machines arrangements are there to analyse different colours of the coloured picture and are able to produce colour prints by using coloured toners.

There is another specialised type of macrographic copier, where the prints are made on a specialised type of paper which have a coating of zinc oxide on it with a special type of resin used as binder. This system is known as elctrofax. With the introduction of plain paper copiers, the use of electrofax machine is reduced sharply and this system became almost obsolete as it is more costly and the special paper which is needed here, gets damaged very quickly by absorbing moisture. The print made by this method is also not permanent and remains in tact only for 3/4 years.

Copyright Act and its effect on reprography

The main aim of Copyright Act is to protect the rights mainly the financial rights of the authors/compilers and publishers. The first such act being the British Copyright Act of 1709. In India, the Copyright Act was first enacted in 1914. The librarians became conscious about the Copyright Act much earlier than the beginning of massive use of reprographic systems in modern library.

The Copyright Act indicates that no document can be reproduced in full or in parts without written permission of the copyright owner of that document. If this provision of the Act is followed with right earnest, then all the work in a reprographic section of a library will come to a stand still, as in modern time the right of a publication is reserved by either the author or the publisher. But the Act as modified in 1956, in section 7 (1), (3), (5), (6) and (9) gives permission to reproduce single copy for use other than commercial without obtaining any prior written permission from the copyright holder. The term 'for uses other than commercial' have a far reaching effect. With the addition of this section the right of the author/publisher is protected as well as the use for educative/research etc., is also facilitated. At the same time the responsibility is also increased manyfold for the librarians and library workers as he is the authority to judge the validity of request of copying a document keeping in mind the right of the authors/publisher, who are not present at the scene. Normally permission is always given for reproduction of a copy, if it is needed for research or educative works.

Before the introduction of mechanical device for coping, scholars and students make their copies as required making hand notes which are also in practice even today ; but there was no much problem in this matter from the copyright standpoint at that time. Mostly because as the hand noteing system is very laborious and time consuming, that no one will go for it unless it is absolutely necessary, and normally question of full copying of documents never arise in such cases. As such copyright holders were not much disturbed by these. But with the introduction of mechanical devices for copying, make it less time consuming, easy and cheaper and therefore extensive copying is now easily possible. This made copyright holders much more conscious. As the Copyright Act allowed proper and legitimate copying, it became essential to understand which can be termed as proper, just and legitimate copying ; which is not defined in the act. Therefore, we have to give attention on four aspects before we give permission for copying e. g., (1) for what purpose the copy will be used, (2) the nature of the publication, (3) the extend of the copy made in comparison to the total document, (4) the possible financial loss incurred by the copyright holder for making this copy.

For review, news reporting, study, research etc·, copying of limited portion of the document is allowed. But there are some documents which are normally not used for researches e. g., pictures, notations etc. From the standpoint of quantity, it can be said that 2 to 4 per cent of the total document can be termed as reasonable. but we cannot consider it to be reasonable or fair to allow copying half or more of the document ; and if the publication is available readily in the market, the question of allowing such massive portion to be copied does not arise at all.

A library can always allow to produce a copy of the rare document it is holding for use of its user or a research scholar. It is also within the norms of library services for reproducing a portion of a publication which is not allowed to be taken out of the library, if that do not effect financially the right of the copyright holder.

In 1935 after a prolonged discussion between the publishers and certain research bodies a decision was made that a library can reproduce a copy for its user, if he gives a declaration in writing that the copy is necessary for his own study or research purposes only. This provision is added in Copyright Act (1958) also. The American Library Association introduced a policy in 1941 mainly depending on this decision for producing copies in a library. In India, the present copyright act is the Indian Copyright Act of 1957 with amendments incorporated in 1983 and 1984. Both Indian and British Acts provide protection for a period of authors' life time plus 50 years. India is also a signatory to Berne Convention in Brussels (1948) and Universal Copyright Convention (1958).

Towards the end of fifties several national libraries formed a committee which made investigations in several universities and research libraries by going through records of copies produced there during last several years and reached to a conclusion that in almost all cases 1935 directives are followed for copying materials in libraries. This report was published in in 1961. It was found from this investigation that most of the requests for coping are made for articles published in periodicals. Depending on this, the committee recommended that before making copies, it is to be find out, if the copy/document is available in the market or not. If it is available, permission for copying full or most part of the document cannot be given. Several libraries in America made an appeal to amend the Copyright Act for making single copying of a document out of the preview of Copyright Act, which was turned down by the joint organisation of the publishers and authors. But if a library hold a manuscript and if it is not available in market, the copying of such document for use by the library is permissible.

Micrography

Micro-photography was first invented in the middle of nineteenth century by John Benzamine Dancer, but it was used for transmitting news for the first time during the war between France and Prussia in 1870. In modern time its use has started in 1920 by George L. Macharty to facilitate work in bank.

During the second world war it was used to protect important and essential documents, and at the same time various improvements in this system were made. From that time onwards it is extensively used in libraries for various purposes. Whenever a system is used extensively, the system gets changed and improved to cope up with its various applications and uses ; samething also happened for this system. Its application in various fields solved some long-standing library problems easily. In this respect efforts of government as well as commercial firms abroad, are worth mentioning.

Various facilities that can be desired from the use of micrography are as follows :

(1) It can help in solving space problem of library (upto 85% to 90%) ;

(2) Possibility of removal or loosing documents from files can be reduced. (A paper can be removed from a file but once it is recorded in a micro-photograph, it is not possible to change the record) ;

(3) Though recorded in a very reduced form, can be easily read using mechanical devices, such as reader etc. ;

(4) Economical for transporting from one place to another. (a thousand page document can be send to another place with a friction of the cost that may be required for transmitting the original document, which saves both time as well as money) ;

(5) It is easy to produce copies, whenever necessary ;

(6) It is good from the stand point of permanence and security. Very old and rare materials can be microphotographed and preserved at a lower cost. If two copies are made, one copy can be used for preservation, whereas the other one can be kept for circulation and use ;

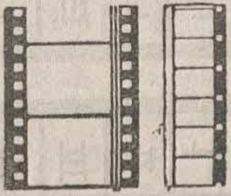
(7) It is easy to maintain secrecy of secret documents.

(8) It is easier to collect information at much lower cost from various documents which are available in different other

libraries, research centres etc., which will help the research scholars in their work.

Various materials are used in the micrography system e. g., (1) Rollfilm, (2) Strip film, (3) Unitised film, (4) Aperture card, (5) Microcard, (6) Microfiche, (7) Ultrafiche, (8) Comfilm, (9) Comfiche (Computer output microfilm) (10) Videodisc.

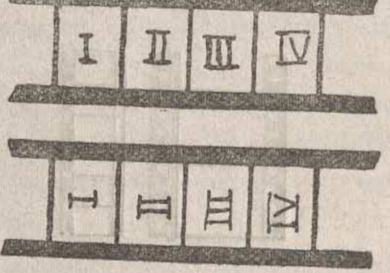
Roll Film : Roll film is available in two forms, in spool and in cassettes/cartridge. In reel or spool, they are available normally in 16 mm or 35mm film size and in cassettes 16 mm films are used. The length of film in spool or reel is about 30.5 meter (100 ft). Film can be of two types—it can be perforated on both the sides, or without any perforations. Naturally in the second case the space available for use is more. Normally, a 30·5 metre long film of 35 mm contain 800 full frames and 1600 half frames. The documents which will not be changed e. g., old newspapers, old and rare documents, books etc., can be recorded in these films. In roll film the documents are not recorded in the same fashion as done in case of cinematographic films (one frame after another from top to botrom), but sidewise one after another (see the picture on the next page).



Roll Film

Within the cassette in which the cassette-film is kept. there are two spools, in one of which the film is rolled. It can be read by transferring the film to the other spool so that the appropriate section can be utilised. But the main difficulty in case of cassette film is that it requires different readers for different type of films, which is not the case with roll films. There are some facilities also in case of cassette film e.g., it acquires much less dust and dirt at the time of use and chances of damage due to those elements are much more limited, The main drawback of roll film is that it can not be referred by more than one user at a time.

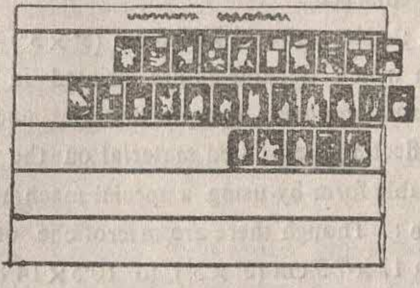
Strip Film : This also can be of two types—16mm and 35 mm. Basically if we cut out roll films in 21·6 cm (8·5 inches) pieces, which will contain 10 full frames, we will get strip



Documentation System on Roll Film (top)
and Cinematographic Film (bottom)

films. Generally these are stored by keeping these in transparent acetate jackets. Use of this type of films are gradually reducing due to various problems in this system.

Unitised film : In this case, the jackets are so made that in each part or section a film can be stored. Though the top and the bottom edges are closed, the other two sides remain open, through which films can be introduced and taken out. Each jacket is divided in 5 to 6 rows. The jackets may be of 10·2 × 15·3 cm (4″ × 6″) or 7·6 × 12·7 cm (3″ × 5″) or 12·7 × 20·3 cm (5″ × 8″) size. In case of films to be stored in jackets only non-perforated films are used. By using jackets some drawback of the roll films are eliminated. It is possible to keep various documents, on same subject together. Documents can be used by more than one user at the same time. On the top edge of the jacket index/subject can be noted in letters readable in naked eyes to facilitate retrieval. Another



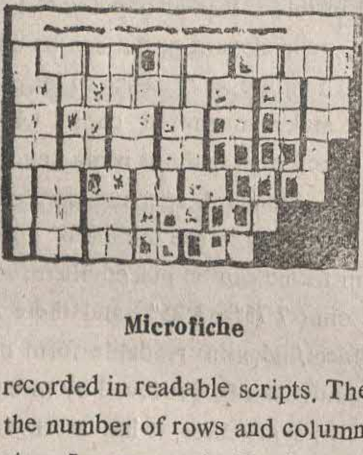
Strip Film in jacket

advantage here is that, if any new information is available, it is possible to add in this. It is also possible to eliminate outdated information, or irrelevant parts can be cut and removed from the jacket. Therefore, it is easier to keep it updated. It is also possible to make magnified copies which are suitable for reading with naked eyes without using any machine.

Aperture Card : Standard aperture card is made up of a card which have a window in the middle of appropriate size so that a 35 mm film frame can be placed there. The size of the card is 18·7 × 8·2 cm (7·75″ × 3·25″) and there is enough space for noting the subject/index in readable form or making such arrangements so that it can be retrieved by mechanical methods or by computer. In some cases, it has arrangement for introducing film, in other cases film remain fixed on it. Sometimes 16 mm film is also used in aperture card. Normally, this system is used to keep technical diagrams and such other things. The main advantages of this system are, (1) it is cheap, (2) due to presence of index or proper retrieval systems, can be easily retrieved, (3) mechanical retrieval is also possible, (4) generally the card used in this system are of very durable and permanent nature and therefore not easily damaged by repeated use or due to unfavourable environments, (5) various equipments for storing these materials are available commercially, (6) it is possible to have copies made readily, (7) can be easily enlarged in required size by use of enlarger.

Microcard : Normally 12 × 17·5 cm (5″ × 3″) is the size of microcard on which documents are printed in very reduced form. This is a completely opaque material and reading can be done by reflecting the printed material on the screen, in an enlarged readable form by using a special machine.

Microfiche : Though there are microfiche of various sizes starting from 12 × 7·5 cm (5″ × 3″) to 10·5 × 14·8 cm (4″ × 6″), yet the bigger one is more popular. It is basically a transparent film sheet. On the top edge of the fiche index/subject name of the materials, is recorded in readable scripts. The reduction ratio is dependent on the number of rows and columns in the fiche—



Microfiche

18·2 × reduction, 5 rows and 12 columns = 60 (known as COSATI format) ;

24 × reduction, 7 rows and 14 columns = 98 (known as Standard format) ;

48 × reduction, 15 rows 18 columns = 270 (known as NAM Type 2 format)

The most important facility in this system is the ability to hold huge documents in a very small area. Various informations collected from different sources can be kept in the same microfiche or different microfiches which can be stored side by side. It can be retrieved manually as well as mechanically. Special type of readers are needed for deciphering information recorded in it, which are known as microfiche reader. Now a days, portable readers are also available. In some readers (which are known as reader-printers), there are arrangements for getting copy of the required portion within a few seconds by pressing a bottom.

Ultrafiche : Actually it is also a film material of 14.8 × 10.5 cm (6″ × 4″) on which documents are recorded in very reduced form, which is much higher rate in comparison to microfiche. As a result of which upto 3280 pages of a normal size book can be recorded within one ultrafiche. The reduction rate is 125 to 250. A reader with special and expensive high magnification display device with powerful light source and short depth of focus is necessary for deciphering these. The production of ultrafiche is a complex, expensive process requiring a laboratory environment and unconventional micro-recording materials and equipments.

There are some other micro-images on paper medium e. g., microprint and microlex. Microprint is still in production and use. Microprint is 14·8 × 22·2 cm (6″ × 9″) card containing upto 100 pages of text arranged in 10 rows and 10 columns at reduction 10x to 24x. Eye readable bibliographic information is provided on the top. Microprints are prepared by employing unconventional technology.

Computer output on film : It is similar to 16 mm reel film but here the rate of reduction is much higher, which may be upto 48x.

Comfiche : This can be described as finer type of microfiche, as here the reduction rate is higher and we can record 200 to 400 frames or pages in one comfiche.

Videodisc : The latest technology which is bound to have profound impact on future library is the videodisc technology. Among the latest developments in storage media are the magnetic tape/disc and optical/laser disc, which have great potential for information storage and retrieval. The optical videodisc include (a) the consumer optical videodisc mainly used for home entertainment and instruction programmes and (b) highdensity storage optical digital disc used for both digital and image storage.

Optical videodisc is a plastic disc similar to phonograph record, containing information both word and pictures, coded in the form of microscopic pits (etched by a high-intensity laser). The disc is read by a low intensity laser beam. One side of such a disc can hold about 54000 still photograph frames. The disc have a video playback time of ½ hour or 1 hour per side.

The optical digital discs represent a very high density mass storage media. At present each side can store 2 × 1011 bits or 41,150 full text pages, which may be increased to 2 × 11012 bits or 411,500 full text pages in near future, if not more.

The optical disc have several major advantages e.g., it can store upto 60000 frames, can be retrieved/accessed via computer disc, have a very long life as a storage media and comparatively very economical, from the production-cost standpoint. It is about 40 times economical than microfiche. But the equipments that are required for reading videodisc is comparatively quiet costly, which is still retradating its extensive use.

The equipments that are required for micrography includes (1) camera, (2) processor, (3) duplicator, (4) reader/reader-printer, (5) film, (6) filing system or storing system.

Camera

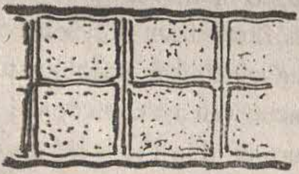
Microfilm camera may of two types : Planetary and Rotary or Flow camera. Micrography camera is slightly different from general camera. In addition to normal camera functions, it has .arrangements for appropriate control of light ; platform for keeping the documents etc. are also included. In the main camera, there is a lens, and also appropriate arrangements for focusing, movement of film, high reduction ability etc. The most important part of it is the high reduction ability. To meet the needs, the camera should be very stout and technically of advanced type, as slightest flaw (such as slight shaking) will result in serious damage of the picture quality.

Planetary Camera : Planetary camera is used to take pictures of a static document and for moving documents Flow camera is used. In a camera there are two reels ; one holds the unexposed film and the other used film. Each camera is provided with such mechanism that after getting exposed through the aperture of the camera, the film automatically moves a step forward towards the used film reel. The light falls on the film through the high reduction lens and by means of self focusing arrangements. The camera can move up and down on the camera stand depending on the size of the document. The aperture is controlled by specialized shutter. This type of camera also have a meter which indicates the amount of film already used, so that it is possible to calculate the amount of unused film left on it. Some camera have special finder light, by using which it is possible to find out which part of the document can be copied, and if necessary camera can be moved up or down to have the copies of the appropriate portion. In other cameras, there are marking on the document board indicating the size of document that can be copied with specific elevation of the camera. In some other cases, this function is done automatically by mechanical methods.

The document platform of the camera is quite big and strong, suitable for holding big documents. The power of the micrographic camera is very high, so that within each millimetre space approximately about 100 or more lines can be accommodated.

Normally lights are fitted on two sides of the camera at 45° with the platform. These are the main parts of camera ; but there may be some other special parts which differs from one camera to other.

Flow Camera : This is suitable for quicker work. Here the film moves at a faster rate, which depends on the rate of movement of the document and the rate of reduction. The document to be copied, will be allowed to move over a drum. The speed of the drum controls the camera, as well as the light arrangement and as a result reduced image is formed on the film. Both the document and the film in the camera move at the same speed. When copying one document is over, the lights goes out automatically and the movement of film also stops. As the next document comes in front of the camera the lights gets on and film starts moving and the proces is repeated. This camera is fully automatic ; in it the aperture to control quantity of light, focus etc., are fixed. It have also some safety measures attached e.g., in cases of mechanical failure or on exhaustion of the film, the same is indicated by some special means in the camera. When operated at full speed, it can take upto 30,000 pictures per hour. If the document is of smaller size, it is possible to use half frame for taking photos.



Use of half frame for recording smaller documents

When the full film is utilised in this fashion, photos can be taken on other half in the same way. Lens of various strength can be used depending on the necessity, so that the reduction can be upto 40 parts.

The camera utilised in microfiche is similar to microfilm camera, only difference is that, in it instead of roll film, sheet film is used and for that reasons there are certain special arrangements to regulate the sheet so that pictures can be taken on one row after another. Generally copying work can be done on this camera at a comparatively slower speed. After each sheet is exposed completely, the same is removed from the camera in darkness and fresh film sheet is introduced, which is also a time consuming process. Nowadays, modern camera can hold 50 sheet films at a time and when a sheet is fully exposed, a fresh film takes its place automatically and the process goes on. In this system it is possible to take 70 pictures per 10 minutes. As an alternative, sometimes 70 mm or 105 mm roll films are used to prepare the negatives of micro-fiche to speed up the work.

Film Processor

There is no difference between general film processing and processing of microfilm or microfiche. But there are some variations in the method due to difference in size and shape etc., and also to eleminate some problems, few mechanical or automatic methods are used.

Reel tank is almost similar to 35mm procesiing tank, only slightly bigger in size to hold films of longer length. This tank is a light preventive plastic container having a reel in it and with adequate arrangement to pour the processing chemical in it. This tank can be of two types – apron tank and spiral tank. In apron tank there is a flexible transparent plastic sheet of about 100 ft (3000 cm) length having grooves at two sides, and is known as apron strip. The film is placed on this strip. In case of spiral tank the film is placed on the spiral reel. When the length of film is 20 to 100 fts it becomes very difficult and almost impossible for putting the film within the tank manually ; that is why mechanical devices are necessary, in which there is a spool holder and electrically operated device to roll the film. Similar mechanical help is also necessary for unwinding film after processing is over. There are arrangements for drying while it is rolled in the reel. In special drying system dry cold or warm air can be blowned on the film for 15 to 20 minutes.

It is also possible to get the processing done by fully automatic machine as in case of cinematographic films. This system is convenient and the product produced is of very high quality, as well as of uniform nature. The main reason behind the high quality output, is that the quantity of the chemicals use and temperature etc., are kept in a fixed position by mechanical means. The chemical coating on modern film is very thin and that is why, it takes very short time for drying. Automatic machines can be of three types, (1) Dipping, (2) Helidally threaded, (3) Roller transport type. Of these the last one can handle longest films, whereas the first one is suitable for shorter films and the second one is meant for handing films of medium length. Whatever may be the type of machine, it should be made of anti-corrosive material ; in this respect 316 stainless steel, titanium and Hastelloy C is very suitable material. There are some type of plastic which are comparatively cheaper in price and can also be used for this purpose.

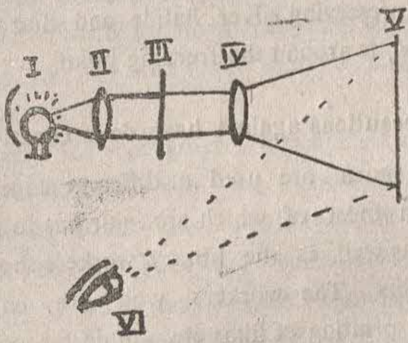
Every machine (specially the automatic ones) have their own specifications for the chemical solution, temperature etc., which are provided in detail literature along with the machines. To get the best possible result, these directions should be followed very rigidly.

Micrographic Reader / Reader-printers

Micrographs can be read with the help of micrographic readers only. The reader-printers are same as readers, only difference is that, it has the added facility by which a copy of the specific portion of the micrograph, can be taken out in readable form on paper within a few seconds by pressing a button.

A reader consists of the following arrangements (a) an optical system for having magnified image from the micrograph; (b) a special type of screen on which image will be formed ; (c) for placing the microfilm or microfiche in proper position for use ; (d) for moving the film / fiche to and fro ; for use, (e) for controlling the temperature within the machine, which increases sharply due to presence of strong light source.

Reading microfilm/microfiche by reflecting enlarged image on translucent screen



I Light, II & IV Lens, III Film, V Screen, VI Reader

In the optical system to have magnified image, high quality magnifying lens, strong source of light and a mirror is necessary. The light passes uniformly through the film and the lens creating magnified image on the screen. In cheaper models of readers only one magnifying lens is provided, where as in high quality costly machines, the number of lenses are more than one. The screen can be translucent or opaque. The type of screen used depend on the technology used in the machine. Both the screen have their own advantages and disadvantages. In earlier times there were separate readers for microfilms, microfiche, ultrafiche etc. But most modern readers can handle all types of micrographs.

Now let us discuss in brief, about the storing arrangements of materials connected with micrographs. All the raw materials necessary for micrographs and the processed meterials are very sensitive and therefore should be stored in air-conditioned room, which should be free from pollutants e. g. ammonia gas etc., as these gases are very damaging to both the raw materials and produced micrographs. The store room should have a temperature of 18° to 22° C and humidity of 15 to 22%. If it is not possible to maintain such conditions, then it should be at least around 50% humidity and temperature of 20° to 22°C. It should be remembered that the most suitable temperature, for preserving silver halide and diazo films in very good condition, is around the freezing point.

Precautions against hazardous chemicals

Various chemicals are used at different stages in the reprography section most of which are injurious to human health. The librarian as well as the library workers should always be alert about this. The workers who are engaged in the developing and printing of films etc., in dark-room come across various poisonous chemicals at different stages. Some of those chemicals can evaporate and pollute the environment within the room ; the intensity etc. of which depend mainly on the room temperature, nature of the chemicals etc. If a workers go on working in this atmosphere for a prolonge period he may be taken ill due to slow effect of pullutant on his body. Mostly the damages are done in the nasal area, lungs etc. In many cases the chemicals which come in contact to skin may leave scar on it or damage the skin or even create some skin diseases. The first step to prevent these, is to make such arrangements so that fresh air from outside can enter the room and replace the polluted air. The workers should always use gloves, while working.

The toner or the chemical vapour used for fixing xerographic copies can enter workers body while breathing and may cause illness in long run. If air-conditioning is not available in such workroom, at least good arrangements for fresh air circulation must be ensured.

The workers who are working with microfilm cameras for a long period daily, their eyes are subjected to light of very high intensity. As a protection against this hazard, they should wear sunglasses while working to save their eyes. Similarly those workers who are working with diazo duplicators, their eyes may be effected by ultra-violent rays. Here also sunglasses should be used for protection. Workers should also be alert about the possible effect of ammonia vapours, which is used in diazo duplicators, on their nose lungs, skin etc. and should take adequate precautions.

In most libraries the reprography departments are air-conditioned. If it is connected with the centralised aircondition system, it should be noted that the air from the reprographic rooms should not be taken back and recirculated after cooling within the library, as the air may contain various gaseous pollution in from of chemical vapours, that may cause serious damages to the library materials in long run.

In addition to all precautionary measures, this department must have a first-aid box ready with emergency medicines and chemicals. Antidotes for various chemicals used here, should be kept ready at hand for use in case of emergency. It is preferable to have a regular medical check up for the staff, who are working in this department.

Library Building and its Conservation Problems

The construction or maintenance of the library building do not come under the duties of the librarian generally. But in practical situation sometimes the librarian have to shoulder some responsibility during construction as well as planning of a new library building. Here we will try to discuss certain points which are relevant to conservation in the planning of library building.

In the library building planning, the first step is the selection of the location. If it is assumed that the responsibility of selecting the location lies with the librarian, then serious attempt should be made to select a spot which is calm and quite, clean and a locality away from the congested area (with lot of noise and polluted air)—as this situation is suitable for conservation, because preservation problems will be lesser in number and smaller in magnitude. But care should be taken to see that it is well connected with all part of the city with adequate transport facilities.

At the time of planning the building, we should consciously think about the sunlight—as we know its (specially the ultra-violet part of it) damaging effect on paper, leather, parchment, vellum, tapes, films etc., in one word almost on all types of library materials. The amount of damage depend on intensity of light and time of total exposure etc. Therefore, the building should be planned in such a way that no sunlight can enter the building. But if it is not possible to eliminate possibility of sunlight entering the building, its entry should be restricted to a minimum by using coloured glass pans (yellow or green) which restricts the entrance of ultraviolet rays in the building. But this procedure have also some adverse effect on the internal atmosphere, as it look odd to have green or yellow light within a room. Nowadays we have a better solution in hand—a special type of thin polyester sheet is available commercially in the market under the brand name "Sun Control", which can absorb major part of the heat (72% solar heat turned away and 28% admitted) and ultra-violet rays (97%) and allow the remaining light to enter the room. Previously this was imported from abroad and was costly ; but now as an Indian manufacturer (Garware Plastics and Polyester Ltd.) is producing it in our country, which is readily available and is comparatively cheaper.

Another important aspect about which proper care should be taken during planning of library building is the security problems. This part can be divided in two different sections—first one, precaution against natural disasters e.g., fire, flood, earthquake etc., and the second one, against the damages caused by human being e. g., mutilation of books, theft etc.

Precaution against fire hazards

Let us first look at the problem of fire hazards in library. From various statistics it is found that the number of cases of fire disaster in library building is very low in comparisons to cases of such problems in general buildings. Mainly this is due to two reasons—firstly, the major reasons behind the fire disasters are absent in libraries e. g., in library building the use of open fire is absent ; secondly both the library workers as well as the users are very much conscious about fire hazards. In spite of these, if there is a fire in library building and on examining the reasons behind the same, we will find that in most cases they are caused either by short circuit or due to some fault in electrical equipments. Sometime smoking may also be one of the causes, though it can easily be avoided with adequate care and precaution from the side of both readers/users and the library workers. Regular examination of electric lines and equipments is one of the most effective remedy against fire problems. But all these are precautionary measures against fire. Now let us explore what are the systems, we must have to fight fire, if it starts in the building. First and foremost duty will be to assure that no human life is lost in the fire and therefore, all library workers should know about the emergency exits of the library and proper indication of such exits should be displayed at prominent places of the library to enlighten the users as well.

Modern librarians are against the policy of having all the stack areas in one side of the building on all the floors, as it may help the severity of fire. The factor which help the fire to increase in intensity and spread, is the supply of air. Normally fire spreads from one floor to other through gaps of the lift or the staircases ; therefore stack area should be away from these.

At the time of building planning it should be seen that, the possibility of fire being spread from adjoining building can be avoided as far as possible. Walls of library building should be very strong and fire resistant, if possible. The wooden door can easily be damaged by fire and also helps fire to spread ; therefore, these should be coated with fire resistant paints. Nowadays there are several types of paints which can resist fire for several hours. Some type of wood is also available commercially, which are fire resistant, as they are treated with certain chemicals ; these can be used to make doors and windows though they are comparatively costly. The roofs separating two floors should be fire resistant as far as possible. In one word at the time of construction of library building, all steps should be taken to see that the spreading of fire can be made as slow as possible, as time is a great factor in fighting fire hazards ; and delay of each moment will be counted very valuable in extinguishing it. If it is not out of the financial ability, building should be as fire resistant as possible. Various systems that can be used in fire fighting is already discussed in a earlier chapter (page 114—18)

Before we end our discussion on this matter, let us mention here the minimum precautions that are normally advised to be taken by the Fire brigade services.

Special precautions for air-conditioning system

(1) The air-duct on each floor should have such arrangements that it can activatise the fire alarm and also the automatic fire extinguishing system (if the same is available) ;

(2) Such arrangements should be made, so that air-conditioning unit can automatically put off, when the fire alarm goes on ;

(3) Automatic fire alarm units should have such arrangements that as it gets activated, all the passages through which air can enter the library building will be closed down automatically :

(4) The air-duct should not be placed on the wall by the side of the staircase.

(5) In air-conditioning unit all the materials used in air filter and similar other parts, electrical system etc., should be fire resistant.

Precaution against flood disasters

Building should be made in such a way that flood water cannot enter the library building. To make this effective the plan of the building will be made after examining the maximum height of the flood water that was reached during last several years (say, 50 years) and also finding out, if there was water logging during the worst flood in that period and if so what was the height of water and then, after giving some safe allowance on it, the plan can be prepared. In abroad buildings have two or three floors underground, which is not very common in our country. But it is worthy to note that in planning such building care should be taken to ensure that flood water can not enter the underground floors. The best way to achieve this is to make the surroundings of the building higher than the normal ground level and also above the maximum level of possible height of flood water. Though care should be taken to see that water connot reach the lower shelf of the stack, it will be best to ensure avoidance of entry of any flood water in the library building as that will make the atmosphere within the building damp and will increase possibility of fuugi and insect attack. The water pipe line within the building should be kept to minimum.

Precautions against damages caused by human being

Normally there should be only one entry and exit point in the library building ; as any increase in this number, will endanger the security. The entry/exit point should be placed in such a position that it will be easy to monitor. There should be space for security staff to sit, and also space for counter for depositing bags, umbrellas etc. There are mainly two ways to encounter book theft—arrangement for compulsory deposition of files, bags, briefcases etc. at the entry point and adequate vigilance in all part of the library. Compulsory deposition of personnel belongings at the entrance should be equally applicable for both library workers and users.

In foreign countries there are some mechanical checking devices, which can be used for avoiding book theft ; most of them are very costly. If these type of devices are to be used in the library, it will be better to plan the entry point accordingly as mostly these machines require a entry path which should not be more that 0.9 metre (3 feet) and in one side of it there should be adequate space for placing the machine and just on the opposite side enough space for putting up the screen. It is almost impossible to introduce such machine in our country considering its huge cost. Under our situation, the best possible way to avoid book theft in libraries (especially college, university library etc.) is appointing of responsible and sincere security staff at the entry/exit point. Once they are appointed, they should be briefed/trained by the library staff, so that they can understand their responsibilities, as well as the functioning of the library in a nutshell. There should be arrangement to give tokens against the materials deposited at the counter ; but the effectiveness of this system will depend mainly on the sincerity of to the security staff. If any case of malpractice on the part of any selfish user come to the notice of the librarian, proper steps should be taken against the user, otherwise moral of the security staff will be effected. In addition to this, if some arrangement can be made to reward the sincere security staff, that will be ideal. It is not necessary that the reward should be financial—it can be of any type—even a certificate in recognition of his good work will also do and if possible, this can be considered as a plus point for giving preference in case of future promotion.

Mutilation of books : These type of damages can be divided in two different groups—one which is done within the library and the other which is done outside the library premises. The damages that are done after the book is taken outside the library, can miss the attention of the library staff easily. The books which contain valuable maps, diagrams, plates etc., should be checked carefully at the time of receiving it back in the library to find out if everything is in tact or not. Similarly it is joint responsibility of both the user as well as the library staff to ensure that the book is complete and not mutilated at the time of issuing out. If any defect is detected, that should be properly documented. Though this checking at the time of issuing books takes considerable time, still it should be done atleast for books with valuable plates, maps etc., as this is only way to avoid embarrassing situations and misunderstanding on the part of both library staff and users. In case of college and university libraries careful checking of the text books should be done at the time of both issuing and taking back, as in many cases it is found that important pages are removed before returning. Though it is true that it is not possible to check each and every book thoroughly at the time of issuing and taking back, still we will have to do it, as far as possible.

To avoid similar incidences within the library adequate vigilance is essntial. Instead of appointment of some vigilance staff, it will be better to introduce surprise vigilance by the regular library staff. It is not important to catch a culprit red handed, but it is important to make the users conscious about the vigilance that is on, so that they will refrain from such selfish activity. One most effective way to achieve this is to draw the attention of the reader, if it is found that there is some defect in the way in which he is using books, and rectifications made. In many libraries it is found that readers are sitting with their legs spread over the chair kept on the opposite side, or he is reading the book folding it in such a way that it may damage the material, or he is writing on a paper keeping it on the book etc. ; in such cases, it is the duty of library staff to go to him and explain his faults. This will have a far reaching effect in reducing the number of mutilation of books, as well as book theft.

Arrangement of various sections in the library

At the time of planning library building, arrangement of various sections of the library should be kept in perspective. The section where the rare collections are kept and the places where it can be consulted, should be placed in such a way that it remain within the monitoring range of either the librarian or any of the senior library staff. Nowadays in some of the big libraries in our country, the use of close-circuit television has been started (this system is in use in foreign countries for sometime past). But due to high cost of its initial introduction, it is not possible to use it in most of our libraries excepting very few exceptional ones, though it may produce good result mainly by creating psychological pressure on users. The main difficulty of close-circuit television is that, as one camera can monitor limited area only, and to have full monitoring of all the areas, several cameras are necessary to which several or a single monitoring screen can be attached. The valuable and rare collection should always be kept segregated in a separate room under lock and key. In case of necessity permission for using such materials can be given by the librarian or senior library staff. In case, it is found that the material asked for, cannot stand the strain of use, necessary alternative arrangement should be made by utilising modern methods e. g., reprography. A discussion about reprography is made in earlier chapter (page 187). The room for storing rare and valuable documents should be so selected that it will not be readily effected by fire, flood or any other natural or accidental hazards.

Normally it is not our usual experience to find burglary or big theft in libraries—may be thieves or dacoits are not very interested about knowledge that is stored in the libraries. From one report it is found that at one time Shakespeare and other good literature became very popular among the inmates of a jail. Naturally there was some discussion about whether the educated peoples are attracted more and more to crimes and the branded criminals are getting attracted to good literature when they are kept away from the anti-social works. It is not known, if Sherlock Holmes made any study on thieves or dacoits, who spend their time in the library, reading good books and left their past profession.

Anyway, all libraries (more specially the libraries who have valuable collections) should take precautionary steps to ensure—(1) the door at the entry point is very secure ; (2) the windows should be securely closeable and strong enought ; (3) walls should be strong and preferably, there should be grills in the windows specially in the ground floor ; (4) there should be adequate security arrangements, when the library remains closed. In foreign countries, at various points within the library, there are invisible light (infra red) or automatic alarm arrangements through which siren can be operated, if any unwanted person enters the building during the period when library remain closed.

Library building must have a anti-thunder device on it to avoid damage due to thunder. In earthquake-prone areas building should be constructed in such a way, that it will not be readily damaged by the tremor. In the storm-prone areas building should be made with the ability to withstand such hazards. Light type of constructions should never be made in such areas.

Creating Environment Suitable for Conservation

While discussing about the enemies of library materials, we have noticed that under certain environmental conditions, fungi, insects etc., grow and spread more rapidly. If the humidity and temperature can be controlled and kept within a specific range i. e., between 22° to 25.5°C and 45% to 55% in case of temperature and humidity respectively, then many preservation problems can be solved.

Air-conditioning System

In a country like ours, it will be possible to control temperature and humidity within a specific range only through proper air-conditioning. But to install air-conditioning in a library or even to maintain it, is a very costly affair. Air-conditioning system not only control the two factors – temperature and humidity, but also help to restrict the entry of dust and dirt, polluted air etc., within the library and keep possibility of increase of acidity to very low level. In this system arrangement can also be made for washing the incoming air with alkaline water to eliminate acidic pollution.

The modern air-conditioning have given a very useful and effective weapon to the hands of librarians in controlling the atmosphere. The air-conditioning, which was thought to be a luxury item in earlier days, from our present experiences and various tests, have proved to be a very useful and almost an essential item for conservation of rare and valuable documents, manuscripts, microfilms, microfiche, audio-tapes, video tapes, gramaphone records and other modern library items. It cannot be denied that in library preservation activity, it is more welcome to avoid a situation, where we have to undertake restoration jobs. That is why to prevent possible attack of fungi, insects and other chemical deterioration, installation of air-conditioning is needed. The best temperature for preservation of books and paper is 19° to 23°C and 45% to 55% humidity.

In a government report in Britain (University Grants Committee. Report of the Committee on Libraries : the Parry report. London. HMSO, 1967), regarding advantages of full air-conditioning, it is stated that :

"Firstly, solid particles of dirt and liquid and gaseous forms of acids suspended in the atmosphere have a seriously deleterious effect on books and manuscripts resulting under the worst conditions in complete destruction of bindings, paper and vellum. Secondly, even in Britain, excessive changes of temperature and humidity accentuate this deterioration and can also lead to additional destruction as a result of the growth of moulds, fungi and bacteria which such conditions favour. For these reasons it is essential that for the best conditions for the preservation of books, the atmosphere should be free from dirt and acidity in gas or liquid form and that temperature and humidity should be controlled ; in fact these conditions are obtained only by the installation of full air-conditioning plant (water washers to extract liquid or gaseous acids, filters to remove solid dirt, heating plant and refrigerating plant). In areas of highly-polluted air it is our view that library stocks, housed both in reading rooms and stacks, can be preserved only in a fully air-conditioned atmosphere."

We can divide the air-conditioning system in several several sections e. g., controlling the air borne solid, liquid and gaseous particles controlling temperature and humidity etc. Controlling of temperature may be of two types – cooling the atmosphere to a specific level or heating it up to reach the required level. Warming up of the atmosphere have some specific problems e. g., if the walls and roof are not enough thermo-resistant, than the artificially heated rooms may lose most of its heat through those areas causing serious misuse of fuel. Whether it is cooling or heating to keep the required temperature within the library, it is essential to ensure proper closing of windows and other ventilators, and it is convenient if their number is low. For library it is more economical to have centralised air-conditioning. In case of heating, using air for the same is not preferable as it requires bigger air ducts in each room. maintenance of which are costly as well as they look unethical. But use of hot vapour is also not suitable. In comparison to these, it is cheaper, convenient and safe also, to have hot water flow in a specific restricted area below the floor and roof ; but adequate care should be taken to avoid any accidental leakage of water pipe and possible damage of properties. The fuel should be selected keeping in view the problems of cost, pollution and suitability.

For cooling the best possible fuel that can be used is electricity. Air can be passed through oil filter so that all solid particles are removed and then by washing in water, the liquid and gaseous air bourn particles can be removed and in case of very dry air the humidity can also be increased. Sometimes thick cloth filter or electric filters (where statical electricity is used) can be used for removal of solid particles from air.

When air passes through refrigeration unit, the excess humidity is removed by converting water particles into ice and remains in the machine and also air loses temperature to reach the required level. Then that cold air is allowed to flow into the library at a specific speed. It is very easy to increase humidity in air—if dry air is allowed to pass over few shallow trays containing water, it will absorb moisture and the rate of humidity will increase.

Though the air-conditioning is very useful for library collection, any defect in the system may cause serious damage to it. It should be ensured that the temperature and humidity throughout the day and night should remain almost constant. Excessive fluctuation of temperature will result in contraction and expansion of paper and other materials and deteriorate their physical condition. If humidity goes down seriously then .papers, papyrus, parchment etc., will become dry and brittle losing its flexibility. The rate of such deterioration will depend on the age of the collection and certain other factors.

From a recent survey it has been found that almost all libraries in United States are air-conditioned. The situation in Europe is also more or less similar. But the picture is just the opposite in third world countries. Though most of the third world countries are situated in comparatively warmer regions and that is why air-conditioning is more needed ; but due to shortage of fund i. e., economic situation, most of the libraries can not go for this facilities, as neither the installation nor maintenance is within their reach. Not even 1% library in India have air-conditioning arrangements. Considering very rare and valuable collection of some libraries, they must try to go for this. In actual position, it is found that in most cases the budget is so limited that it gets exhausted even to run the day to day routine works. Therefore, before going for air-conditioning libraries in India and similar other developing countries, librarians should seriously think if it will be financially possible to maintain it properly or not.

As it is already said that financial condition stands in the way of air-conditioning libraries, in few libraries where there are some very valuable and important rare collection, they should try to solve the problem by installing room air-conditioner for the room in which such collections are stored. This is normally known as Rare Collection Section. In this way some solution is achieved with much less cost.

Other than high cost, there are some other problems for air-conditioning system in hot countries like ours. In summer, the temperature within the air-conditioned library remains around 22°C, where as the temperature outside, reaches around 40°C and that situation will result to physical discomfort and also may lead to illness to users, as well as library workers. It is very difficult to solve this problem. To solve this, some suggest that the working areas and the reading room should be kept outside the air-conditioning system. But at least some staff will have their duty in the stack area too. In rich countries where the residence of staff are also air-conditioned and air-conditioned transport etc. are available, such problems do not arise.

While discussing about the library building, we have indicated that the number of doors, windows should be limited to a bare minimum, and wall, roof etc. should be thermo-resistant as far as possible It is easier to install air-conditioning in a new building made with all such provisions than to introduce it in a old building, as it will require lot of additional jobs which will be costly affair.

From the discussion so far, we can infer at least in four cases air-conditioning can give very good results e. g., controlling humidity ; controlling temperature ; filtration ofair—through which we can get rid of the pollution, dust, dirt and other materials causing acidity ; and proper circulation of air.

It can be said that by using proper air-conditioning 75 to 80% of conservation problems can be solved. Investment in air-conditioning may reduce the fund required for preservation to a very low level. From that standpoint it can be suggested that those libraries who have the financial ability to undertake air-conditioning, they should go for it for good result and economy in future. But it is almost a impossible proposition for most of the libraries in countries like ours and therefore we have to find out what other systems, we can undertake to help our conservation efforts. In very dry weather, we can place shallow wide surfaced trays filled with water in the stack areas to increase the humidity level. The number of tray will depend on the size of the room and dryness of air.

In rainy season, when the humidity rises to a very high level, the water containing trays should be replaced by small saucers/dishes containing dehumidifying chemicals e.g., anhydrous calcium chloride, anhydrous bauxite, silica gel, activated alumina etc., which should be placed in different part of the stack area. Considering cost and convenience to use, silica gel is the best chemical that can be used. About 1·75 to 2 kg. of silica gel is enough for a space of 600 to 800 cubic meter. In case of extreme humid weather chemical should be replaced with fresh one after every 3/4 hours. If the used silica gel is heated to 95°C, the moisture absorbed by it will be evaporated and it will be ready for reuse. From the point of initial cost silica gel is costlier than anhydrous calcium chloride, but as the later cannot be reused, the former becomes cheaper in ultimate consideration. Nowadays there are some mechanical and electrical devices available for controlling humidity within a room.

Stagnant air alongwith humidity may cause problems in the library in form of spread of fungi and insects. For that reason proper air-circulation should be ensured in the library. Adequate windows and ventilators can help in this matter and proper utilisation of air-circulators/fans will give good result. In case of too cold atmosphere room heaters may be used. But adequate care should be taken in using this type of equipments—these should not be placed too close to books or other library materials as that may result in loss of humity and even fire may start from these. Care should also be taken so that temperature do not rise excessively. Too many windows and ventilators will cause problems like dirt, dust, pollution etc., within the library.

We have already seen that a part of light is damaging to library materials e. g., the ultra-violet rays. Normal tube light contain more ultra-violet rays in comparison to the incandescent bulbs. Therefore when it is not required, lights should be put off (it will also help saving electricity which is also important in our country). In those places where it can not be put off, the tubes should be properly covered to absorb the excess ultra-violet rays.

Some suitable actions in the storage area is helpful for the conservation efforts, e. g., books of ordinary size should be kept standing on the racks. If they are kept in a slanting position both paper and board will be damaged. Books should not be placed in a tight position on the racks ; there should be empty area for air circulation and it also help to take out books from the shelves more conveniently. Book support should be used to keep the book in proper position. Very long or broad i. e., odd-size books should be placed flat on the racks. But in no case more than 3 to 4 books are kept one above the other. If the books are very thick and heavy they should be placed individually on the racks. Adequate care should be taken both at the time of placing and removing books from the rack.

We have discussed about cleaning and dusting in a separate chapter. Conservation staff should give attention in addition to this to find out which books need restoration, binding and those should be immediately taken out of circulation and proper steps are to be taken to restrict possibilities of further damage.

At the time of making photocopies from bound books or periodicals, care should be taken so that too much pressure is not applied on the sewing of the binding. In this connection, it should be noted that the binding in library should be such that the books or periodicals can easily be open flat without applying much pressure (french sewing is necessary for this purpose, detail discussion on 'this is made in a later chapter).

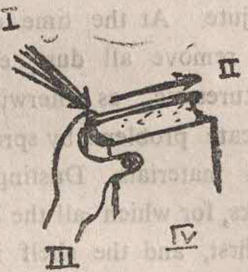
In many cases, it is found that users of the library do not use the materials properly, to enlight the readers/users in this matter notices/posters can be used. Library staff should also take conscious effort to make them understand the problems, so that they can rectify their habits.

Some Essential Activities for Conservation

One of the most important problem of our libraries throughout the year is the problem of excessive dust, dirt etc. This again give rise to other problems like fungi growth etc. Therefore, we have to be conscious about dust and allied problems from the very beginning. This problem is almost absent in air-conditioned libraries, but as we have already seen that very few libraries can afford such an expensive system in a country like ours. Therefore, in the libraries who cannot have such arrangements, attempts should be made to restrict the entry of dust etc. in the library as far as possible ; if required by keeping glass panel of windows closed or by using coloured curtains. It is true that inspite of all these efforts certain amount of dust will find its way in the library, which can be removed first by carefully sweeping the floor then removing the remaining fine dust with the help of moistened cloth or jute. At the time of sweeping attempt should be made to remove all dust, even from below the rack and other furnitures etc., as otherwise the accumulation in those area will create problems by spreading from there to books and other materials. Dusting should be done regularly on all racks, for which all the books from one shelf should be removed first, and the shelf is cleaned with help of cloth duster. Feather duster should not be used as it will help spreading of dust from one shelf to other. In case of very dusty shelves where it is not possible to remove all the dust with dry cloth duster, slight moistened duster will be helpful (this is possible in case of steel racks only). This dusting work should be started from the top shelf first and then move downward as while dusting upper shelves some dust will naturally spread to the lower shelves. Use of vacuum cleaner for dusting is very effective, as with this dust can be sucked within a small bag provided for this purpose and chances of spreading from one place to other is reduced to a great extent, if not totally eliminated.

The accumulation of dust is maximum on the top edge of books which are kept on the racks in standing position ; in addition to that, on folds of cover and in binding, some amount of dust also get settled For cleaning each book, first that should be pull out of the rack and hold with moderate pressure on the top edge on the side of the spine, then if air is blown by mouth, dust will be dislodge from the top end. If all dust cannot be removed in this way, a soft brush should be used to clear it holding the book in the manner described earlier, otherwise some amount of dust will find its way within the pages. When top position is properly cleaned ; the book should be opened at the cover and closed suddenly with pressure so that dust particles inside the folds of the cover will be disclosed and then brush should be used to remove the remaining dust.

Cleaning a book



I Path of blown air, II Direction of dislodged dust,
III Hand position for holding the book, IV The book.

In countries like ours, where the climate is hot and humid, the attack of insects is very common. We have discussed about this problem earlier. Once any such attack starts the best way to control it, is to spray insecticides like Pip, Begon, Shelltox, Finit etc. These chemicals do not have any serious adverse reaction on library collection, though these are very effective against insects e. g., cockroach etc. If 10 to 15 drops of Aldrin or Dieldrin is added to 1 litre of Pip or Begon, it will give better results. Library should be sprayed with this type of insecticide at least twice a month. At the time of spraying operation, more attention should be given to places where insects can be found occasionally e. g., at the cracks of the walls or floor, below the racks, in the corners of rooms which are comparatively darker and places which are rarely disturbed etc.

Benzene can also be used for protection of books ; particularly if the books are kept segregated in a room or within an almirah (as in case of rare books, maps etc.) it is more effective.

In olden days to protect manuscripts and such other materials our forefathers used black peppers, tobacco leaves, neem leaves, camphor etc. These materials loses their smell, which acts as insect repellent with passage of time, and fresh materials should replace the old one after every two months or so. This system was fairly effective for a very small collection.

During earlier days creosote mixed with kerosene oil was either sprayed or applied with the help of soft cloth on the wooden shelves or cracks of the walls to fight against insects effectively, specially termites. This system is still in use in small libraries in rural areas. Sometime it is found that tobacco leaves and neem leaves are put between the pages of books, but this type of practice should be avoided as it may damage the paper.

If the attack of white ant i. e., termite is detected, immediately steps should be taken by using 1% Sodium arsenite and 20% Zinc chloride with water. Using 5% DDT with kerosine oil is also fairly effective. Nowadays a chemical is available in market, known as Termex, which can be slightly diluted with kerosine oil and used with very good result. But it should be remembered that attack of white ant cannot be stopped by spraying of chemicals alone. If cracks are created on floors and walls by termites, those should be first treated with white arsenic and cupric arsenite mixture or Sodium fluoride and creosote mixture and then those cracks should be sealed with cement. In case of wooden furniture 1 part of coal tar creosote mixed with 2 parts of kerosine oil or mixture of 1 part chlorinated phenol, 1 part B-naphthol mixed with 40 parts of petrol should be applied on wood. The intensity of attack can be reduced for the time being by spreading/applying around the effected area with BHC dust, DDT, Chlordane, Sodium arsenite, Pentachlorophenol etc. Termites eat up dead bodies of their co-workers and have a habit to lick up each others body, these two habits help us to get very effective results by spreading strong poisonous chemicals around effected areas. White arsenic, DDT powder, 1% Sodium arsenite mixture in water or 5% DDT mixture in water is very effective weapon to fight termite problem. To get good preventive result creosote should be applied in a mixture form with kerosine oil at least twice a year on wooden furnitures of which one application should be done just after the rainy season.

In case of serious attack in library, full eradication of all insects can be done with the help of hydrocyanic acid fumigation for 48 hours. But this should be done with utmost care and under the supervision of experts. After fumigation two days should be allowed to keep the library closed so that all traces of poisonous vapour are removed. Fumigation with methyl bromide (for 24 hours) also given some limited effect.

Use of DDT, BHC or spraying of Chlordane mixture in spirit and application of those by spraying or with brush etc., help reduction of attacks as well as resist future attack for sometime and therefore it should be applied at regular interval, at least where insect problem is very acute.

The best way to fight insect problems is to keep the library, its environment clean. The furniture should be painted at least once in every five years. In case of wooden rack, trollies, etc., insecticide chemicals should be mixed with paints at the time of painting for better result. If possible steel racks should be used instead of wooden ones (though they are slightly costly). Racks with adjustable shelves are more convenient for use, as shelves can be adjusted at required. Height of racks should not be more than 6 ft 5 inches (192.5cm), otherwise it becomes difficult to use the top shelf. Steel rack is also preferred as these are less effected by fire and neither help spreading of fire, nor insect attack and do not absorb moisture, as in case of wooden ones.

Problems of Restoration and Preservation of Water Damaged Materials

Library collection can be damaged by water in various ways. In one sense, the damages caused by excessive humidity is also a type of damage caused by water. But the damages caused by humidity is mainly due to absence of proper healthy atmosphere within the library. In such a situation attack and growth of fungi is very common, which can damage books and other library materials in various ways.

Other possible damages due to water, are mainly caused by the structural defects of library building. If the library building, have water pipes within and they are placed in areas away from general notice of library staff and users, and if pipe starts leaking, generally it will take time before it come to the notice and by that time materials placed under it or in surrounding areas may be damaged. The intensity of damage will depend on the time lag before noticing the incidence, amount of water accumulated, materials which are subjected to this situation etc.

But the most intensive damage caused by water, is due to flood or similar other natural calamity, to which condition many of our small libraries are subjected. The most important and famous such incident that happened was on 22 June 1972 in Glass city of New York state in America and the most damaged library was Corning Museum Library. The incidence of the libraries damaged by Florence flood in Europe is also worth mentioning. In September 1976 due to non-stop rain for about a week causing severe unprecedented water logging in and around Calcutta city and adjoining districts caused severe damages to many libraries including the State Central Library of West Bengal. Other than flood, sometime it is found that after a fire in a library, lot of books are damaged by water which was used to control the fire. We have already discussed in an earlier chapter how to prevent and avoid such calamities.

Whatever may be the reason, the water damaged materials may be divided in two groups (a) materials with major damage and (b) with minor damages. The damages that may be caused due to water are of three types – (a) Weakness in the material caused by changes in physical conditions : It is found and proved through experiments that water soaked papers becomes very weak and tear easily with slight pressure or stress. When moist, dirt and dust gets accumulated on them easily. (b) Weakness caused by chemical or physical damages : At the time of manufacturing paper, the pulp contain some materials which are soluble in water, e. g., resin, adhesives, gelatin (used in sizing) etc. These materials are washed away if paper remains in water for a considerable period. The adhesives, that is used for calendering etc. on paper can be softened and as a result pages may be stucked to adjacent ones. (c) Attack of fungi and similar other problems : Fungi can grow very easily on wet paper, particularly if vegetable adhesive or starch is present in it, as these provide nutrition to fungi.

The method which will be followed for restoration and preservation, mainly depends on the intensity of damage done. the number of damaged materials and the library fund available for this purpose.

Method of preservation and problems : In most cases, if the papers are dried keeping together, they can readily be get stuck to adjacent ones and it becomes very difficult to separate them. This problem is caused by softening of the sizing materials by water. To prevent this, in the wet condition each page should be separated from the other cuarefully and kept separate by blotting papers placed between them and then allowed to dry under pressure. When a paper is almost dry, the drying proccss can be speeded up by using a slightly warm iron. Drying can be done in various ways ; but if the number is not very high then drying can be done slowly at normal temperature.

If the quality of paper effected is very good, the chances of damage is much less though the paper may swelled up or get wrinkled by wetting. To restore wrinkled paper, few such sheets should be taken together and should be polished with mild pressure with the help of wet sponge. This process should be repeated till all papers are treated.

Those books which are fully wet, should be opened properly by separating each pages with the help of blotting papers (which should be changed after certain intervals) and allowed to dry under pressure. When fully dry the pages should be resized properly.

If the book is slightly moistened, that should be treated in similar manner that of a fully wet book. Special precaution should be taken for books printed on art paper, as it is found that in these cases, the pages get stucked to the next one so strongly that it becomes very difficult to separate them from each other. If the number of such book is high, hot vapour (at a temperature of 110°C) should be passed over them which will kill bacteria that are responsible for such stucking and it becomes easier to open the pages. After the pages are open they will be dried by keeping them in hot air. In certain cases, it is observed that this method do not give good result. The books which are made up of such paper in which starch or protein is used for sizing, enzymes can be applied to separate the stuck-up pages. Enzymes help the separating procedure, but it cannot do the same on its own and therefore, only a small quantity of enzyme is necessary for such purpose. The main cause of stucking is use of some adhesives in sizing and loading the paper. These adhesives may be of two types, (a) composed of starch or carbohydrate ; (b) composed of protein. The type of enzyme to be used for separating job depends on the type of adhesives used.

Treatment of paper where starch/carbohydrate based adhesive is used : In case of paper where starch/carbohydrate based adhesive is used, clinical standard diastase mixture in water (5% solution) at 20°C should be used for good result. The paper or ink is not effected in this method. In cases of very old printed books neutral solution (pH 7·0) alpha amylose at 65°C should be used. Though this method produces good result, still some experts express their doubt about its usefulness. Their objections are mainly based on the observations that in many cases it is found after opening the pages that the ink became fade and paper became softer and weaker.

Starch is a mixture of two types of chemicals—which are two stages of glucose. Now the proportion of the two, depends on the source of starch. But it can be generally said that starch contain 25% amylose and 75% amylo-protein. To destroy this starch very small quantity of enzyme is necessary. First the amylose and the amylo-protein should be converted to dextrin. This can be easily done by using alpha amylose which converts the amylose fully and amylo-protein partially to dextrin. This dextrine can be readily removed. If the temperature is kept between 37° to 39°C and pH around 6·95, minimum quantity of enzyme (maximum of 5% solution, weight/volume) will give excellent result. The time required will depend on the fact that how quickly the solution can penetrate the paper. After the reaction is over the enzymes should be washed out with water at about 20°C and finally with hot water at 50°C.

Treatment of paper where protein based adhesive is used : Protein based adhsives are mainly of animal origin and normally mixed with vegetable glue before using. The adhesive prepared from flour also contain certain amount of protein in it. In case of adhesives of this type 0·5% (weight/volume) Tripcine can be used at 40°C and pH 7·4, with good result. Apart from this 0·5% (weight/volume) Protease at 40°C and pH 7·45 can also be used. It can be said that no adhesive that is used, can be of only protein base; it will have certain amount of starch in it also. That is why alpha amylose should be used first, which will be followed by protease ; because alpha amylose itself is a protein. It is therefore possible to destroy the traces of alpha amylose that remains in the paper by using protease.

In those manuscripts where colour or coloured ink is used, special care should be taken. First of all the ink should be made permanent by use of either cellulose acetate in acetone or polycrinyl solution in toluene. It should be always remembered that protease should never be used on manuscripts of vellum or parchment, as these mediums are made up of protein and will be damaged by protease

Now let us see how we can get the best result by using enzyme First it should be ensured that the ink is made permanent and it will not be damaged and then only we can start our next step.

Enzyme can be stored in plastic bags along with silica gel in the freezer of refrigerator. Solutions of appropriate strength can be made at the time of use, which can also be stored in the freezer. But it should be remembered that this solution cannot be stored for long, as it get destroyed within few days It should be first decided that what type of adhesive we have to destroy – starch based or protein based or a combination of both ; as the selection of solution will depend on this only. 900 ml of water should be heated to 40°C and to it 100 ml of appropriate solution should be added. Now hot water will be taken in the sink on which the container tray will be placed and in it the dilute solution will be poured. There should be a thermometer in the tray, so that the temperature of the solution can be monitored regularly. The temperature of the solution should remain around 37°C, as at a temperature of 40°C or above, the enzyme get destroyed and on the other hand, if the temperature drops appreciably, the effectiveness of the solution will decrease sharply. If it is necessary to remove starch based adhesive, then 1 gm (1 teaspoonful) alpha cellulose should be added to the solution and stirred slowly. Now the paper to be treated should be placed between two protecting sheets (so that the original paper is not damaged easily) and slowly dipped in the solution. Close watch on the temperature of the solution should be maintained and slow stirring of the solution continued. It is not possible to indicate what will be exact time taken for removal of all the adhesives – it may be anything between half an hour to about four hours. To find out if the reaction is over or not, we will have to place a blotting paper on the sheet and that should be dipped in dilute iodine solution. If purple markings appear on the blotting paper, it should be understood that still some starch is left on the paper.

In case of removal of the protein based adhesives the dilute solution should be taken in the same way and to it 1 gm of protease should be added and the temperature of the solution should be around 37°C. When all the adhesives are removed in this way, the paper should be washed properly and if necessary, deacidification should be done and finally resized to make it usable.

Restoration of Weak Paper by Lamination

Paper gets weaker for various reasons e. g., due to aging, constant use, insect attack, due to effects of water etc., and ultimately becomes unusable. To avoid and get rid of this situation restoration is needed and one of the ways of restoring such material is lamination. During restoration work, often we find that there are various stains on the paper, which should be removed before actual restoration job is started. To do that we have to first find out the reason of such stains and how they actually appeared on the paper. There are some materials which can remove one type of stain, but can make certain other stain permanent, instead of removing it. Therefore, it is essential to identify the chemicals which have caused the stain.

We all know that the most used material which can remove stains is water – mainly because it is easy available, cheap, safe, odourless, non inflammable and non-poisonous in nature. We have used the term 'safe' for water, as it normally do not harm most materials, including paper if used in small quantity. The other solvents excepting water, which are used for removal of stain are benzene, alcohol, chloroform, petrol, toluene etc. Normally these materials are applied with the help of soft brush or cotton or soft cloth. The side of the paper on which the stain is noticed should be kept on a clean blotting paper and the chemical should be applied from the other side in small quantity and if necessary, the blotting paper should be changed occasionally. This process should be continued till all the stains are removed. If the proper solvent is selected and application is done properly, the stain will be removed altogether. We come across various stains on library materials, the reasons of which are different and various chemicals can be used for removing them. We are providing below a list of various reasons of stains and names of solvents which can be used to remove them against each.

Reason for stain	**Solvents to be used**
Tar	(a) Petrol ; (b) Benzene ; (c) Carbon tetrachloride ; (d) Pyridine
Iodine	Ethyl alcohol
Ink—Fountain pen	5% Oxalic acid
Copying	Methelated spirit and ammonia
Printing	Initially terpene, then petrol
Marking	Potassium ferro-cyanide solution
Coffee	(a) Hydrogen peroxide ; (b) Initially potassium permanganate, then dilute sulphuric acid ; (c) Potassium perborate
Mud	(a) Water ; (b) Ammonia.
Grease	(a) Alcohol ; (b) Petrol ; (c) Pyridine ; (d) Benzene ; (e) Trichloroethylene ; (f) Terpene ; (g) Chloroform ; (h) Carbon tetrachloride ; (i) Carbon disulphide.
Tea	(a) Hydrogen peroxide ; (b) Potassium perborate ; (c) Initially potassium permanganate, then dilute sulphuric acid.
Fungi	(a) Ethyl alcohol ; (b) Benzene
Gum	Slightly warm water
Shellac	Ethyl alcohol
Adhesive (General)	Water

Wax : (a) Petrol ; (b) Chloroform ; (c) Carbon disulphide ; (d) Alcohol ; (e) Pyridine ; (f) Benzene ; (g) Terpene ; (h) Trichloroethylene ; (i) Carbon tetrachloride.

Lacquer : Acetone

Paint : (a) Benzene and alcohol mixture ; (b) Initially pyridine, then water ; (c) Terpene

Oil or oily substances : (a) Alcohol ; (b) Carbon disulphide ; (c) Carbon tetrachloride ; (d) Chloroform ; (e) Terpene ; (f) Pyridine ; (g) Petrol ; (h) Benzene ; (i) Trichloroethylene

Burnish : (a) Alcohol ; (b) Acetone ; (c) Pyridine

Iron rust : (a) 5% Oxalic acid ; (b) Citric acid ; (c) Sodium hydrosulphide ; (d) Tartaric acid

Lipstick : Initially 5% tartaric acid, then water

Blood : Sodium hypochloride

From the table given above it is apparent that different types of solvents can be used for removal of different stains. Most of these solvents are inflammable and many others have offensive smell. Some of them are hazardous to human health, if not used with adequate care. The room or laboratory in which these chemicals will be used must have very good ventilation system, so that damaging effects of vapour of the solvents can be minimised.

After removal of the stain from paper or manuscript, those are cleaned and then strengthened by restoration. In this matter special attention should be given to certain matters such as, readability of the books or manuscript should not be effected, its original shape and form should be protected as far as possible and it should be strengthened to the maximum extent.

Even a though theoretical knowledge about restoration is not enough, for real good restoration work practical knowledge is essential. Each and every restoration procedure have got some advantages as well as disadvantages. Therefore it is essential to find out which procedure will be most beneficial for that particular restoration job. If corner of a paper is torn slightly due to careless handling, it can be repaired easily. But when paper gets weak due to aging or such other reason, repairing of the same is both time consuming and laborious. The most useful and effective method for this, that can be applied is lamination.

For repairing manuscripts, books etc., any of the following materials can be used e. g., tissue paper, chiffon, silk, cellulose acetate foil etc. In case of materials with one side printed or written paper, repairing can be done by pasting a strong supporting paper on the blank side. Sometime torn pieces can be found out and placed in the appropriate position ; small holes in the paper can be repaired with the help of paper pulp or tissue paper.

Several chemicals can be used to strengthen weak papers. These chemicals include (a) 10% solution of Cellulose acetate in alcohol (this solution is known as Celit) ; (b) 1·5% solution of soluble nylon in alcohol at 40°C can be applied. (this is known as Calton solutions) ; (c) 2·5% to 5% solution of caboxy-methyl-cellulose in water (this solution is known as Glutofix) ; (d) 1% to 5% solution of polyvinyl alcohol in toluene. These solutions should be applied on the damaged paper or page, either by spraying or applying by soft brush.

RESTORATICN OF WEAK PAPER BY LAMINATION

Application of these chemicals not only strengthens the paper but also effectively prevent future deterioration to a great extent. This process is known as chemical lamination.

When paper becomes very weak and brittle or swells up, for its restoration tissue paper or silk of good quality and of appropriate thickness and weight, should be used. These can be applied on both side of the paper. It is comparatively easier to use tissue paper and if it is properly applied the presence of tissue paper is not noticeable easily. In case of slight or moderately damaged paper application of tissue paper is enough for repairing, as no further step is necessary and a paper repaired in this method will not get deteriorated in future. Though use of silk/chiffon instead of tissue paper make the paper stronger but the effect will last only for 25 to 30 years. This can be used for very damaged book or paper printed on both sides and if properly used its presence is not easily noticeable.

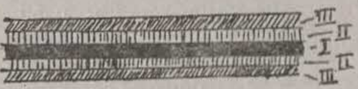
If there is any folding on the paper, that should be opened i. e., its original condition should be restored before repairing. The materials to be used for repairing should depend on the condition of damaged paper, the amount of printing or writing on it, etc. If the paper have printing on one side only, handmade paper of appropaiate thickness can be used on the reverse side ; but in case of papers having printing/writing on both side, only silk/chiffon or tissue paper can be used. Whatever may be used for repairing, to get the best result it should be ensured before repairing that the paper is properly made free from all flaws e. g., acidity, humidity etc.

The chiffon, that is used for lamination purpose, is of very high quality having uniform fibres on all side and about 90 to 95 fibres per 2.5 cm (1"). The tissue paper which is most suitable for lamination, is Japanese tissue paper—Tosa B or Mino AA.

In case of tissue lamination, the damaged weak paper is placed between two tissue papers and fixed in that position with help of adhesive. The adhesive that can be used for lamination must have certain properties e. g., other than its adhesive nature, it must have some protecting and anti-insect/anti-fungal properties and it should not have any damaging reaction on paper. Further more it should be such that it becomes easy to apply and if necessary, should be reopenable without any damaging effect on the paper. Various types of adhesives are used for this purpose; we will discuss about them in the next chapter.

The most effective and appropriate method of lamination for very weak paper is cellulose acetate lamination. In this process, first a tissue paper and then very fine (.00088" thick) cellulose acetate foil is placed on which the damaged paper is kept covered with another sheet of cellulose acetate foil and

Tissue Lamination



**I Damaged paper, II Cellulose acetate foil,
III Tissue paper.**

tissue paper and then both heat and pressure is applied on them, so that they get fixed. The tissue paper to be used for this purpose must be fully free of wax or any oily substance. To properly apply heat and pressure, normally it is covered or wrapped in cloth coated with teflon and placed between two hot metallic plates. The temperature of the plates are between 145° to 155°C. Cellulose acetate foil melts at this temperature and the pressure applied by the plates are between 39 to 40 kg. per cubic centimetre. It is allowed to remain in this condition for 2-3 minutes, then the pressure is released and the paper comes out of the machine through a roller. Now the extra tissue paper is trimmed after keeping a margin of about 3 mm on all sides. The cellulose actate lamination process was invented by American National Bureau of Standards in 1935. In the beginning a steam operated hydrolytic machine was used which was very costly. William James Burrow devised a smaller and comparatively cheaper machine in 1938, in which he used electricity to heat the plates and utilised roller to apply pressure on the paper. In this machine it is possible to generate pressure of about 140 to 933 kg. per 2·5 cubic centimetre (300 to 2000 lbs per cubic inch). In this machine no separate device is necessary for cooling which was essential in previous machine, where steam was used for heating. Another facility is that as the pressure is applied through a roller from one corner of the paper, the chances of leaving air bubble in the laminated material became nil, which was a frequent problem in case of previous type of machine. Along with this machine William J. Burrow developed the modern cellulose acetate foil lamination. Before that tissue paper was not used for this type of lamination, resulting in serious problem in the repaired paper which became otherwise strong. The problem is that—it can be easily torn or folded. But with the use of tissue paper the problem can be overcomed easily. The thickness of the paper do not change appreciably by this type of repairs—as both tissue paper and cellulose acetate sheet/foil are very thin.

Lamination of weak paper with tissue paper and cellulose acetate foil without using any machine

It is not possible for smaller libraries to have a lamination machine and that is why a system is introduced to have lamination done without using any such machines. This process is extremely suitable for our country and a modified system that is introduced by Indian National Archives is discussed below. Though no machine is used in this process, the result obtained is no way inferior.

In this system, a clean glass sheet is taken, on which the damaged paper is kept, and will be covered by slightly bigger (on all sides) cellulose acetate sheet and on top Japanese tissue paper is placed. Now with a soft cloth or cotton, acetone will be applied on the tissue paper slowly, starting from the centre and moving towards the edges. As a result of the reaction with acetone the celluose acetate foil become soft and get fixed with the tissue paper and the damaged paper. In this way when work on one side is over, it will be allowed to dry in open air. When fully dried the same procedure will be repeated on the other side. When the process is over the paper is allowed to remain under moderate pressure for one or two days. When fully dried the excess acetete foil and tissue paper will be trimmed to proper size with the help of sharp scissors. While working in this process, care should be taken to ensure proper ventilation in the working room as acetone vapour may cause damaging effect on health. It should also be remembered that acetone is a highly inflammable chemical and adequate precautions should be taken. This process can also be used with chiffon instead of tissue paper.

Repairing with tissue paper in laboratories : Two pieces of wax paper of slightly bigger size than the damaged paper, which is to be repaired, will be taken ; one of which will be placed on the table on which the damaged paper will be kept. Then with broad soft brush dextrin adhesive will be applied on the paper. After uniformly applying adhesive on the paper, a tissue paper is placed on it carefully, without any fold or wrinkle in it and the page should be smoothed in such a fashion from one edge to another, that no air bubble may remain in it. Now the page is allowed to dry in open air. After the page is properly dried it will be placed on other piece of wax paper with repaired surface at the bottom and the whole process is repeated on this surface also. After complete drying the page should be left in moderate pressure for one or two days. The same procedure can also be carried on with chiffon instead of tissue paper.

Polythene lamination : This process is devised in 1970 and now used in many countries with good result. Like the cellulose acetate foil polythene sheet is also applied on both side of damaged paper with the help of heat and pressure. The thickness of polythene sheet used for this purpose is between .03 to .04 mm. The temperature of the plate, with which heat and pressure is applied, is preferably around 120° to 130°C. In absence of costly machines in smaller libraries hot iron can be used to do this type of lamination. Nowadays polythene is readily available in our country and therefore, in case of necessity, we can easily utilise this process.

In case of lamination of paper, manuscript or any other matter, using tissue paper, chiffon, polythene etc., we must remember that the job should be done in such a way that—

(1) flexibility of manuscript should not be affected ;

(2) whatever may be the system or process used, it must be reversible ;

(3) colour of the manuscript should not be changed ;

(4) readability should not be affected ;

(5) nothing should be used which can react with the material of the manuscript ;

(6) there should not be major change in thickness or weight of paper or manuscript.

In case of certain types of manuscripts e. g., palm leaves, birch barks, very old paper, etc., we have to use special type of lamination in which very thin sheet of cellulose triacetate can be utilised. This type of lamination can be done within one to two minutes with help of plates heated at 60°C.

Encapsulation : In this system the damaged paper or manuscript is placed within a jacket of cellulose acetate, polythene or polyester, whose open end is closed either by chemical adhesive or adhesive tape. In this case neither heat, pressure nor any chemical is used. As in this method the damaged material is kept away from polluted atmosphere, damaging chemicals, fungi and insects etc., but whenever necessary can easily be taken out of the jacket. This system is gradually becoming popular method. This process not only prevent further deterioration but also serve to strengthen the manuscript to a certain extent by virtue of support it is providing on two sides. It is not a restorating method in true sense of the term, it is more a useful storage system.

As there are some difficulties in using artificial adhesives and adhesive tapes etc., nowadays some new machines are devised in which either heat or ultra sound vibration is used to seal the opening of the edges. These machines are very costly and beyond the reach of small and medium libraries and also for most of the big libraries in our country.

Various Types of Adhesives used in Different Works in Libraries

Adhesives are used by man since very early days. From that standpoint it can be considered as a very ancient material of human use. But during last few decades there have been lot of changes in the field of adhesive technology as a result, there are various types of artificial adhesives now available in the market. Therefore, the question naturally arises, which adhesive is to be used for what purpose to get the best result. Though the question may look small and short ; the answer is not so simple. To understand the problem we have to first discuss about various types of adhesives in brief.

The major utilisation of adhesive is done in binding work. But in most cases, it is found that adhesives used in binding are harmful to books. Generally, adhesive do not damage paper, though paper becomes slightly weak in contact of adhesives. Most adhesives when dried becomes very hard and may form sharp edges, which when bend, may crack. This type of adhesives are not suitable for use in library.

The function of adhesive is to hold together two pages or two other medium, this function is done either mechanically or chemically. The result is achieved mechanically in the following way—on the surface of paper where adhesive is applied, small holes are created and the adhesive that dries in it forms a dumb-bell like structure, which act as joiner that holds two papers together. This can be observed on examination of a cross section of papers joined together by mechanical system under microscope.

Chemical function of adhesive can be observed if we examine two papers joined together by that method through a simple experiment. Two pieces of paper are taken—one is simple ordinary paper, where as the other one is wax paper. On paper thin layer of adhesive is applied. It will be noticed that in spite of wetness of ordinary paper, the wax paper remained unaffected. The layer of wax resist any effect on the paper. If the adhesive is of very high quality the joining will be very strong and durable ; any attempt to separate the two papers will result in torning them, but they cannot be separated.

When the adhesive can soak the paper well, we can term it as good adhesive, as without this quality, the function of of joining cannot be achieved, as it happens in case of attempts joining wax papers. For this reason the adhesive should be fluid enough so that it can easily spread on the medium to be joined (e. g., paper). It should have another quality of quick drying. Therefore it is apparent that there are three steps or stages in joining with adhesives e. g., first the liquid stage—so that it can be applied easily ; second stage—were, after proper applications the two pages are kept together and in the last stage, joined by drying. The second and the third stage varies in different types of adhesives, e. g., animal glues cool down to a thicker mass and dry up slowly, and vegetable adhesives gradually evaporate to dryness. The adhesive used in repairing and restoration job is of vegetable origin, but adhesive that dries by evaporation have some problems also, e. g., during drying the paper or the medium may wrinkle slightly. But if the wrinkling is heavy then it will damage the paper/medium, as well as the joining will be weak and impoper. At the time of selecting proper adhesive, it should be remembered that more strong and durable adhesive should be used for harder mediums. If it is too fluid, it may damage and weaken paper through expansion due to soaking. Keeping these in mind, we will have to use different types of adhesive for different purposes.

VARIOUS TYPES OF A DHESIVES

Adhesives can be divided into three groups depending on the constituents e. g., (1) vegetable origin, (2) animal origin and (3) artificial or synthetic.

Starting from the days of Egyptian civilization till date, adhesive that is used in majority cases, is of vegetable origin, of which the most common one is starch The main reason behind this is that though it takes more time in drying, yet it has all the qualities of a good adhesive ; over and above that, it is cheap, easily available and also easy to use.

Generally, if one part of flour or starch is mixed with 10 part of water and the mixture is boiled to get the adhesive. Slight changes and modifications are incorporated in this process to make it more suitable to modern time e. g., to prevent fungi attack certain chemicals are added to it. Starch adhesive is flawless and of higher quality than flour adhesive.

From simple starch high quality adhesive with distinctive characters or properties can be produced by following some special methods. As for example, if starch is subjected to a reaction with acid or alkali or oxidising agent and then one part of it is mixed with one part of water, the adhesive that is produced will not be too thick for use. In another process, if a small quantity of acid is added to starch and warmed in medium temperature or if baked at a higher temperature without adding acid, the white dextrin or yellow british gum is produced respectively These will give good quality adhesive when mixed with water at 1:1 proportion. This type of modified starch is also available commercially in the market which facilitate its use in smaller libraries.

Preparation of vegetable based adhesives

(A) Thin Starch Adhesive : Following ingredients are required to prepare thin adhesive—

Starch	250 gms.
Water	5 litres

Clove oil	40 gms.
Safrol	40 gms.
Barium Carbonate or Lead Carbonate	40 gms.

Water is first heated to 80° to 90°C and then starch is added to it, with constant stirring to ensure proper and through mixing. After that lead or barium carbonate should be added followed by safrol and clove oil in the same fashion with continuous stirring and properly mixed. The whole mixer is then allowed to boil at a low temperature for six to eight hours. Now the adhesive is ready. In the same method 250 gms. of flour can be used instead of 250 gms. of starch.

(B) **Starch Adhesive :** Following ingredients are required to prepare this adhesive—

Starch	200 gms.
Water	1 litre
Copper sulphate	2-3 gms.
Glycerine	2 gms.

Water will be first heated and then starch added to it with continuous stirring and the mixture is allowed to boil for about six hours at low temperature. When fully prepared glycerine is added to it. In this process also flour can replace starch.

(C) **Flour Adhesive :** To prepare this following materials are required—

Flour	250 gms.
Water	1 litre
Formalin	10 drops

Flour will be added gradually to hot water with continuous stirring and the mixture is allowed to boil at low temperature for six hours. When the mixture is ready formalin is added to it with constant stirring.

(D) Dextrin Adhesive :

Dextrin	2·5 kg.
Water	4 litres
Clove oil	7 gms.
Safrol	38 gms.
Lead or Barium carbonate	64 gms.

Among the ingredients clove oil and lead/barium carbonate are used for their anti-fungal and insecticidal propererties respectively. Water is heated to 90°C and then dextrin is added with continuous stirring to make a through mixture. When mixture is ready lead/barium carbonate and finally safrol and clove oil is added to it with continuous stirring and then the whole mixture is allowed to boil for 6 to 8 hours on a low flame at a lower temperature.

(E) Carboximethyl Cellulose Adhesive : One kilogram of carboximethyl is added to 5 litres of slightly warm water and mixed thoroughly. Generally this adhesive is used for repairing birch bark manuscripts.

Preparation of animal based adhesives

Various types of animal skin, hide, bone etc., are used to produce animal based adhesive. Mostly leather waste is used for its production First, hairs are removed by soaking it in lime water and then it is allowed to remain in the solution to which more lime is added, till these swells up. Then these are removed from the solution and washed with adequate water to remove all traces of lime from it. Finally it is heated with warm water to produce adhesive. If required, all the water can be evaporated slowly to get dry and hard adhesive flakes, which can be dissolved in water when necessary. The adhesive produced in this manner may be of different qualilies. It can be generally said that adhesive produced by slow heating will be of better quality.

In similar manner adhesives may be produced from bones. Only difference is that to remove unwanted materials from bone, it is necessary to use some amount of acid. Of all animal based adhesives gelatin, albumen, casein etc., are used for different works in different fields. As animal based adhesive dries up very quickly, it is mostly used in binding operation to facilitate the work. It is more suitable for those books whose spine will be rounded off. Hot animal adhesive can penetrate paper more easily in comparison to its counterpart of vegetable origin and physically help joining more effectively particulary on rough surface and that is why, it is extensively used in binding. This type of adhesive always contain certain amount of gelatin in it. Higher the proportion of gelatin, the drying period is shorter. But in case it dries very quickly, it becomes difficult to work with it.

Though at the time of preparing it, alkali or acid is added, in the final stage, no trace of these can be detected. This type of adhesives are available commercially either in flakes or powdered form which can be easily dissolved in cold water to make it ready for use. Small amount of carbolic acid can be added to it, to induce insect preventive properties.

Preparation of artificial adhesive

During last few decades several types of synthetic adhesives have appeared in the market. Each of them is suitable for some specialised uses ; few of which are also suitable for use in library. Most of the synthetic adhesives are plastic or polymer based. These can be broadly divided in two groups— thermo-plastic and thermo-setting adhesives. As raw materials either phenol and formaldehyde mixture or urea and formaldehyde mixture are used. Nowadays in some cases melamine is used instead of urea.

In case of thermo-setting materials very high temperature is necessary at the time of application, in which the form once taken cannot be changed, not even by applying heat. Any material joined with the help of this type of adhesive can only be separated by cutting. Therefore, it is obvious that this cannot be used for any conservation work in library. Its application is more or less limited to furniture and similar other industries. Apart from this, its dangerously acidic nature is another important factor which prevent its use in library. In future, if these factors change, then only possibility of its use in library can be considered.

There are various types of thermo-plastics ; some of them are suitable for use in library. Its main characteristic is that though it is produced from polymer, its shape can be easily changed with application of moderate heat as it gains its flexible nature on application of heat. Some thermo-plastics are flexible like rubber whereas others are hard. The thermoplastic which is most suitable for use in library is polyvinyl acetate, specially, in liquid form. It may take the place of starch and animal-based adhesives in future. It is very stable as well as helpful to library conservation. In normal condition it is almost transparent granular material, which becomes soft on application of heat (less then 100°C). Apart from this, there are few solvents e. g., Dibutyl phthalate can convert it to soft and liquid. But it is not suitable for use in library in this condition. In liquid condition it is comparatively more easily usable than the animal based adhesives. Its extensive use in the field of book binding have already started. It can be mixed with water easily to increase its fluidity which becomes water resistant when dried. It do not require pressure to join materials with the help of this. In case of fixing chiffon, tissue paper, nylon etc., it is more suitable then general adhesives. But it should be remembered that it is preferable to use on both sides of paper. One of its main drawback is that it easily dries on the brush making it unusable. But this problem can be easily overcome by cleaning the brush in methylated spirit, acetone or ethyl acetate etc., when use is over. But best way to avoid this problem is to keep a small water container handy, so that the brush can be dipped in it after use.

Various other adhesives

Several other adhesives e. g., gum arabic though used extensively for general purpose is not suitable for use in library as it easily absorbs moisture and not suitable for permanent joining. Rubber solution which is prepared form naphtha or carbon tetrachloride was used for sometimes in binding job during last century (around 1870). As it was easy to use and maintain a flexible condition immediate-after use, it was then thought to be a suitable replacement of conventional adhesives for binding. But it was later noticed that its stability is very low and ultimately its use was abandoned.

Binding

The main objectives of binding are to ensure preservation of written, near print or printed materials through a process of enclosing the loose pages within permanent covers. Binding became a fine art in the fifth century during the Bizenstaine civilization, which came in existence as a result of interaction of the declining Roman civilization with the oriental civilization.

In all libraries, some books will be found, which are damaged due to constant use (the pages become loose and coming out of the covers, which is almost torn etc.), and requires binding for proper preservation. Again, there are books which are not referred very often, but they are old, valuable and rare. The environmental conditions may have resulted in deterioration of their physical conditions or the library have collected them in a very weak and deteriorated condition—for all such materials proper binding is essential for conservation, in addition to other steps.

The binding work differs from one library to the other. Therefore the type and size of the binding department depends directly on the factors e.g., the necessity, workload, availability of fund etc. Inspite of all these differences in various libraries, the main binding procedures which consist of gathering, guarding, sewing, rounding and backing, attaching permanent cover etc., remain the same in all binding departments, whether they are big or small. To get quality binding, it is essential to have efficient and skilled binders in addition to quality raw materials e. g., good thread, board, leather etc. These will ensure that the bound books will be more durable and will remain in good condition for a longer period, even after repeated use. At the time of binding special attention should be given on four aspects e. g.,—(a) flexibility, (b) durability, (c) strength, (d) perfectness i. e., retaining original condition as far as possible. Flexibility of bound book is important, because it help to consult the book more conveniently. To make the binding flexible special care should be taken for proper sewing and using appropriate end paper. One of the main objective of binding is to increase the durability of the material, to achieve which good quality thread and other materials should be properly used. The strength of binding is required so that it do not loose its shape or form with passage of time. Good quality board helps to increase the strength of binding. It is very important to ensure that the perfectness or original position of the material is maintained during binding as its absence will result in damaging the original material.

Before going into detail about various steps of binding, let us discuss about one or two aspects about paper e. g., size etc., in addition to what we have already learnt about paper, its raw materials, manufacturing procedure etc. Size of paper sheet varies according to the variety of purpose for which it is intended. Some common standard sizes of paper mainly used for book work with their commonly accepted names are indicated below :

Foolscap	43·2 × 34·4 cm (17″ × 13·5″)
Demy	57·2 × 44·5 cm (22·5″ × 17·5″)
Medium	58·2 × 45·8 cm (23″ × 18″)
Royal	63·5 × 50·8 cm (25″ × 20″)
Crown	50·8 × 38·1 cm (20″ × 15″)
Imperial	86·2 × 5·9 cm (30″ × 22″)

In double sizes the smaller measurement is doubled, in quadruple ('quad') size, both dimensions are doubled – i.e., the measurement of double crown is 50·8 × 76·2 cm (20″ × 30″) and quad crown is 101·6 × 76·2 cm (40″ × 30″). A crown sheet folded once, giving two leaves and four pages, is crown folio ; folded again, giving four leaves and eight pages, is crown quarto (4to) ; folded three times, to give eight leaves and sixteen pages, is crown octavo (8vo). This method is used to specify the size of a book.

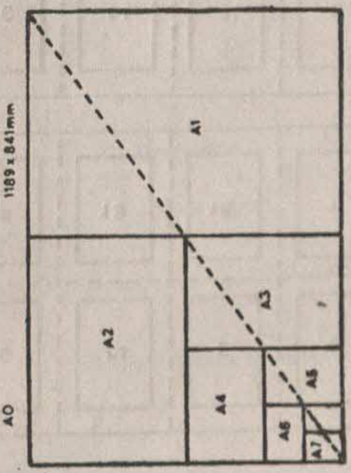
The worker in a bindery has to be familiar with old paper sizes (which are indicated above) as well as the modern international ones. The International Standards Organisation (ISO) decided on a standardization of size and shape of paper based on a square meter, subdivisions of which retained the same proportions, to make reductions and enlargement easier. This standardization simplified paper manufacture, printing, binding and the production of associated machinery through out the world. The ISO measurements are :

A size	(used for standard printing etc.)	118·9 × 84·1cm
B size	(used for posters, charts and maps)	141·4 × 100·0cm
C size	(used for envelops)	129·7 × 91·7cm

The unfolded size of A size paper (one square metre) is known as Ao. Folded once, this becomes A_1(84·1 – 59·4 cm) ; folded twice, it gives A_2 (59·4 × 42·0 cm) ; folded three times this becomes A_3 (42·0 × 29·7 cm) ; folded four times, it gives A_4 (29·7 – 21·0 cm) and so on. Stock size papers are slightly larger than the trimmed size of paper and have the prefix 'R' before the size. The size of RAo is 122·0 × 86·0 cm.

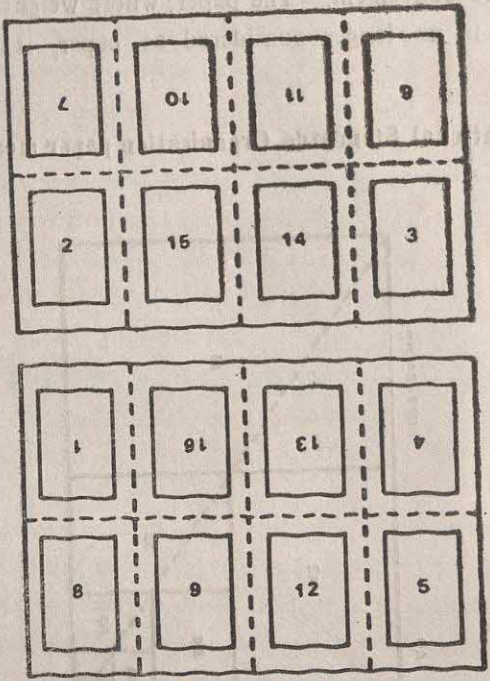
Another term which is often used to describe paper type is 'pound weight', which indicate the weight of one ream of paper expressed in pounds ; it is expressed in term of kilograms also in certain cases. This often led to confusion about the actual content of the paper of various sizes and nowadays this has been replaced by expressing the weight in grams per square meter of paper (gsm). This system is known as 'grammage' which remain, constant for paper in a ream. This system is much more convenient. The paper, whose weight is 220 gms. or more, is no longer considered as paper, it is termed as 'board'.

International Standards Organisation paper measurement



To facilitate printing of a book, pages are arranged in some specific order so that after printing, when the full sheet of paper is folded, the pages will run consecutively. The special order that is followed for the quarto is 8, 1, 5, 4 on one side and 2, 7, 3, 6 on the reverse. In case of octavo the sequence is 1, 16, 13, 4, 8, 9, 12, 5 and 7, 10, 11, 6, 2, 15, 14, 3 respectively (see diagram). If this sequence of printing (which is called as "imposition") is known, it becomes convenient to fold the sheets. Normally library binding department do not have to handle folding of full printed sheets, as they mostly handle the books which are produced after

Imposition

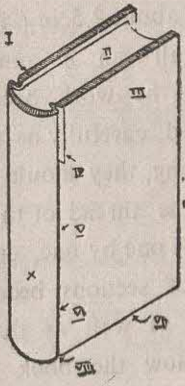


folding the full printed sheets. Normally each format have 16 or 8 pages but they can be of 32 or 64 pages also.

Before discussing about binding in detail, let us find out what are the various parts of a book. In the following three diagrams attempts are made to indicate various parts that a book can have. Each part have its own utility towards strengthening, the book. A thorough knowledge of these helps the worker to take adequate care in appropriate aspect of each step resulting in better end-products.

Most of the binding works done in library, are actually rebinding jobs. Therefore the first step for starting binding work in library, is to check if all the pages of the book are alright or not (this is known as 'collating') ; a note should be

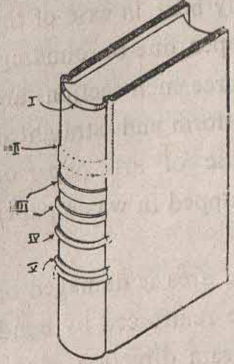
Various external sections of a bound book



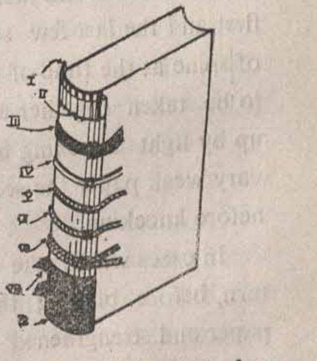
I Back board, II Head, III Front Board, IV French grove, V Flush joint, VI Outer joint, VII Tail, VIII Back corner, IX Foredge, X Smooth spine.

made for all plates, maps or pages which are damaged, torn or missing or have dirt stains, fox marks or stains due to any other reason.

Different parts of spine



I Head cap, II Tape, III False band, IV Raised cord, V Double raised cord.

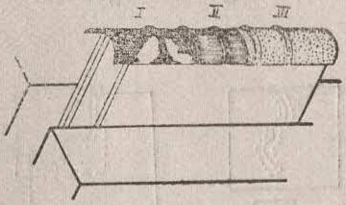


I Head band, II Head band tie down, III Tape, IV Vellum slip, V Sunk cord, VI Raised cord, VII Double raised cord, VIII First lining (mull), IX Second lining (kraft paper).

The format of the book should be separated one by one with adequate care, so that the fold, or pages etc, are not adversely effected or damaged. In case of a book with publishers binding, after removing the cover, the board should be cut at a distance of about 2.5cm (1 inch) from the spine, so that tape, endpaper, mull can be removed easily. If the glue and linings are brittle the work becomes easier. The initial pages should be checked carefully as in some cases they do not have any page numbering, they should be arranged and kept in proper order. Then the thread of the first section will be cut to separate the sections one by one, carefully. Due to hardness of glue, if separation of sections becomes difficult, then the cover from both sides as well as the covering of the spine should be removed. Now the book will be fixed on finishing press and thick layer of dilute adhesive is applied on the spine and allowed to remain in that condition for about 10 minutes ; the old lining will be softened by adhesive and can be easily scrapped off by the back of a knife. In some cases this process should be repeated to remove all glue from spine. Now each section should be cleared of remnant of hard glue, thread etc., and the sections should be arranged serially. It will be found that the end facing spine is slightly bent in case of the first and the last few sections, which happen due to rounding. of spine at the time of binding. Two or three such sections are to be taken together and put on iron platform and straighten up by light knocking by hammer. In case of art paper or vary weak paper the sections should be wrapped in waste paper before knocking.

In cases where the paper on the spine area is damaged or torn, before binding that areas should be reinforced by bond paper and strengthened. After noting the grain direction of the paper, it should be cut slightly longer than the page and about 10 mm wide, on which adhesive should be spread properly leaving the end dry and will be placed on thin, clean waste paper (with adhesive upward). The section will be carefully taken and placed in such a way that it covers half the width of the pasted guard paper. The waste paper should be folded tightly against the fold of the section, so that the bond paper is turned over on the top of the section. After rubbing, it down to place it properly the excess bond should be trimmed off. In case of very valuable and rare books this type of repair should be done using japanese tissue paper instead of bond paper.

Various layers on spine



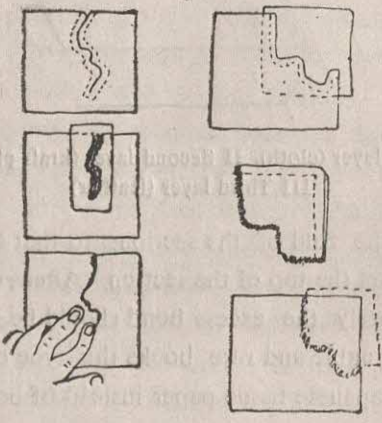
I First layer (cloth), II Second layer (kraft paper), III Third layer (leather)

In some books loose maps, plates etc., are found ; for their proper storage a pocket can be attached to the back board. The size and shape of the packet depends on the number and size of the plates, maps etc. If number of such materials are considerable or if the size of pocket required becoms quite thick, arrangements should be made at the time of preparation of spine by adding a compensating section of guards of equal thickness.

We have already said that note should be made for all pages that may be found missing at the time opening the binding. Now to start the job of rebinding the first step will be to acquire copy (preferably photocopy) of the missing page(s) and place them in their appropriate position. In case of rare and valuable books serious attempts should be made to trace the missing page(s).

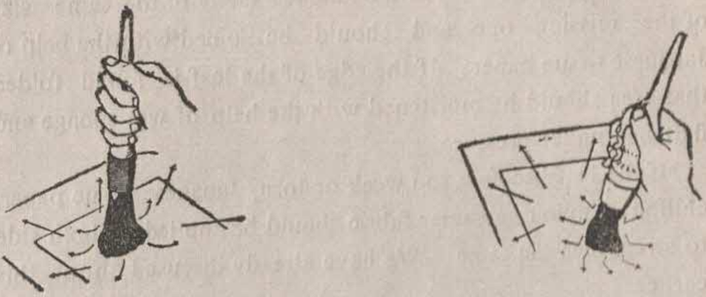
Now let us see, what can be done about torn or damaged leaves. The torn leaves are repaired by placing the torn piece in the appropriate position and joining the edges with mild pressing of a blunt needle, after which thin layer of adhesive will be applied by thin brush. Now Japanese tissue

Repairing of damaged leaf



paper of slightly bigger size in comparison to the torn piece will be placed on the repaired portion so that no wrinkles remain on it ; similarly tissue paper will also be applied on the reverse side and dried in air. When fully dried, the excess paper will be rubbed off. If there is any risk of discolouring or damage of paper due to general adhesive, artificial adhesive can be used. In such cases tissue paper will be first placed on glass sheet and on the same artificial adhesive (polyvinyl acetate mixed with equal amount of water) will be applied with the help of thin brush. When dried the tissue paper will stuck to the glass. Now, a solution will be prepared by mixing Methoxymethyl nylon with 2 gms of Calaton C. B. and 100 ml Ethanol at a temperature of 60°C. Adequate care should be taken at the time of preparation of the mixture as both the components are highly inflammable and these chemicals should be kept away from direct contact of flame.

Proper system of application of adhesive



When this hot mixture is applied on the tissuse paper it will automatically be loosened and can be peeled off the glass sheet. This tissue paper can be stored in the silicon release paper, and whenever necessary can be cut into appropriate size and placed on the torn leaf and subjected to heat applied by heated iron after being covered by silicon release paper resulting in proper fixing of tissue paper.

Nylon gossamer fabric can also be used in place of tissue paper. As the material is transparent and very thin, it remain invisible when used. The polyvinyl acetate adhesive will be applied evenly with help of broad brush on the glass sheet on which nylon gossamer fabric will be smoothly spread and peeled off immediately and kept aside with gummed side on top. The glass sheet will again smeared with the polyvinyl acetate adhesive and the process will be repeated. Then the fabric will be dried in air and should be stored in silicon release paper to be used whenever necessary by applying heat with help of hot iron.

If torn piece of a leaf is lost, the repairing work should be done with a piece of paper of slightly bigger size (about 2 mm) of same colour, weight, texture, grain and if possible of age.

The piece should be placed in appropriate position with adequate care, so that if possible no part of the printed area is covered and even if covered, the area should be kept to bare minimum. If there is any chance of adverse effect on readability, the piece should be made exactly of the same size of the missing one and should be joined with the help of Japanese tissue paper. If the edge of the leaf is found folded that area should be moistened with the help of wet sponge and flattened under pressure.

If the leaf becomes too weak or torn, Japanese tissue paper, chiffon or nylon gossamer fabric should be applied on both side to strengthen the same. We have already discused about this earlier.

Occasionally it is noticed that old books have different stains on their pages which are caused by dirt and various other reasons. If the book is very valuable, it will be wise to spend enough time and effort to remove the stains. But adequate care should be taken in this process to avoid any damage to the book/manuscript. In this respect following steps can be taken according to the sequence indicated. As the next step is more damaging then proceeding one, we should proceed upto that point which is absolutely necessary and stop at that point itself and not move any further. (1) Dust should be removed using soft brush ; (2) Soft rubber granules spread over the paper and rubbed with cotton ; (3) After soft rubber, comparatively less soft rubber should be used to clear the paper ; (4) If the paper is strong enough, very fine sandpaper may be used for light rubbing with extreme care.

To remove oily stains from paper or vellum, carbon tetrachloride can be used. This chemical have no adverse effect on water colour or ink and as it evaporates very easily, leaves on trace on the medium on which used. Cotton slightly moisten with this chemical can be used with light pressure on the leaf to clear the same. If enough chemical is taken on cotton, that may damage the medium. Its vapour have also some adverse effect on human health and therefore, it is advisable to cover the nose with a handkerchief. The best proposition is to do the work in an open area or a well ventilated room. It should be remembered that the chemical is very costly.

To remove ink stain 10% citric acid solution can be used. After use and removal of stain the leaf should be washed in flowing water for about 30 minutes to remove any trace of the chemical and it should be sized properly before binding.

Before dipping a leaf in any form of solution it should be ascertained that the same do not have any damaging effect on it or on ink. Small quantity of chemical should be taken in a fine brush and applied on a corner of ink marking and after waiting for about 10 minutes, the ink marking should be examined under magnification glass to see if there is any sign of ink spreading, which signifies its damaging character. If any sign of adverse effect is noticed, nylon solution should be used to make the writing permanent.

To remove the stains caused by fungi attack (foxing) any of the following three solutions can be used—(1) solution of 1 to 5 gms Sodium hypochloride or (2) 1 to 5 gms Calcium hypochloride or (3) 5 to 20 gms of Chloramine T in one litre of water. No other solution should be used. Of these, the last one is most suitable, though it acts very slowly. In case of seriously stained leaf, the same should be kept dipped in the solution taken in a large shallow tray, till the solution turns yellow. When the solution turns yellow it indicate, the strength of the same is exhausted and it became unusable. After cleaning the paper, the same should be washed in flowing water for three hours and to be sized after drying properly.

Gelatine is available commercially both in granule and sheet form. This can be used for sizing good quality paper. A mixture should be prepared by adding 5 gms of gelatine in 4 litres of hot water. After washing paper in water the same should be dried with help of blotting paper and the fully dried paper should be kept dipped in the hot mixture for 15 minutes. After removing the paper form mixture, excess liquid should be removed by blotting paper and then the same will be allowed to dry either keeping it hanging or in between two wax papers under moderate pressure.

Sizing can be done by another mixture. 250 gms of parchment or vellum pieces should be boiled for 1 to 1·5 hours in 1 to 1.5 litres of water. The mixture should be shieved through a fine muslin and should be used for sizing at 40°C.

Other than these 5% solution of soluble nylon in methylated spirit can be used for sizing very weak and soft paper. This solution can be applied with the help of fine soft brush on written areas to protect the soluble ink, water colour etc. which can be effected by water.

To make the pencil drawing and writing permanent a solution of 15 gms of Izinglass in 600cc of water can be applied.

After the leaves are cleaned, repaired, strengthened and dried, they should be kept under pressure for at least 24 hours. For fine binding the pressure should be applied for seven days. Binding should be done only when the leaves attend the most condensed condition. Pressure drives out all air from the leaves and felting action takes place between the paper surfaces and after pressing is over sections become solid block.

During pressing, the bigger books should be placed at the bottom and smaller one above them, so that the smallest one occupies the topmost position. After several hours of application of initial pressure, the same should be increased, as it is possible due to the elimination of appreciable amount of air from different sections.

If the book contain smaller mounted plates or in case of manuscript containing raised gold or painted decorations the pressure should be applied with great care, otherwise both the painting and the paper may be damaged seriously. If necessary cut pieces of waste paper may be used for protecting. It should always be remembered that no part of book should be damaged due to application of pressure. In case of very old manuscript where handmade paper is used, the same should be slightly dampened before undergoing pressure treatment, as this will help spreading of fibers at the time of pressing. In case of newly printed books, if there is any possibility of offsetting of printing (which is more common in case of coloured plates), interleaving with tissue paper should be done.

Endpaper : The main function of endpaper are two fold—the outer half prevents the covering board from bending outwards and the inner half protects the first section of book that may be damaged due to pressure at the time of opening and closing. Therefore, its use is more than mere decorative —it makes binding stronger and durable. The endpaper have undergone evolutionary changes during various ages in different countries. In the primitive period it was very simple and was not suitable for adding any strength to binding. In various periods different binding houses and various craftsmen contributed towards the development and improvement of endpaper.

The paper for endpaper should be of high quality and adequate strength. Handmade paper is not very suitable for this purpose as they are not very stretchable and create problem at the time of sticking. In this respect it can be said that white cartridge paper is most suitable for endpaper to be used in general binding. But experiments have indicated that various other types of paper are also suitable for some specific type of binding. If coloured paper is used for endpaper, the colour should be selected in tune with the colour of the covering materials.

The very cheap and weak endpapers, which are normally used for publishers binding, do not have any sewing in it ;

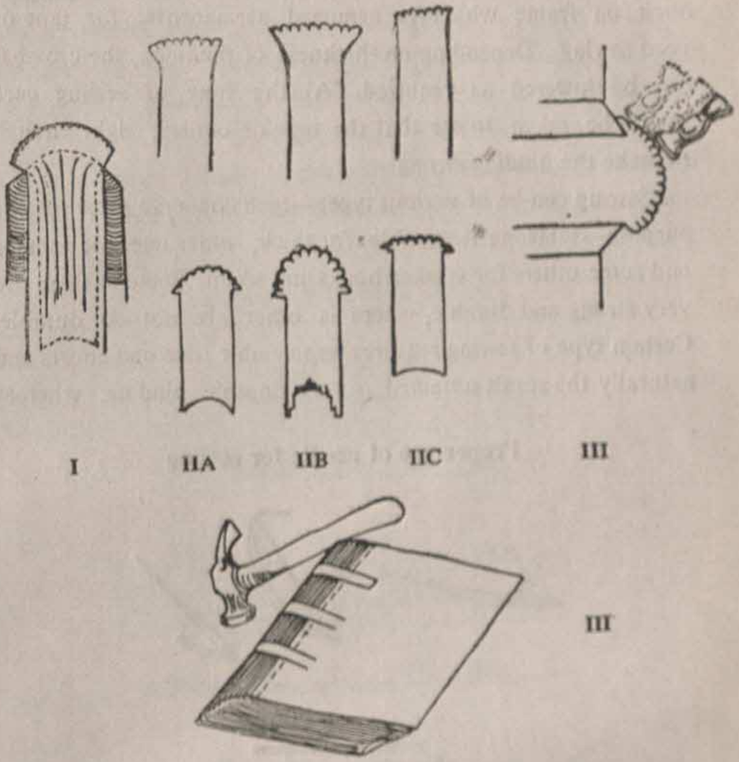
they are fixed with the first section towards the edge of spine with adhesive on 3 mm (·25 inch) areas.

In case of more durable binding, the endpaper is fixed with the first section of the book both by sewing as well as with adhesive. In this type of endpaper there are four leaves of which the second and third are pasted together to give an appearance of a thick paper. Though in case of thick book it do not create any problem, but in case of thin book, this thick page looks odd. At the time of sewing care should be taken so that the page which will be fixed with the board do not get perforated.

The endpaper, which is most suitable for library binding (as the same is neat as well as strong), have cloth of about 5cm width on the side, which will remain towards the spine, but it is not visible from inside. The major portion of cloth remains on the board or paper that covers the board ; the other portion remain between the first section and the adjoining endpaper which is pasted to the same. This type of endpaper is also sewed to first section of the book. One variant of this type of endpaper is not very decent to look, as the cloth is visible from outside, but is very strong and durable. In this case second and third as well as fourth and fifth leaves are pasted together. The end that is near the spine is made up of cloth (3·75 cm i.e. 1·5 inches wide) which is sewed with the first section of the book and cloth is visible from outside in this part The type of cloth is dependent on thickness of the book and similar other factors.

Let us now examine the spine of the book. From the very primitive age of bookbinding till today the appearance of spine have undergone various changes—spine became more roundish now, which ensures uniform pressure on each section of the book. In earlier type of binding, most of the pressure was on the first and last few sections. But total appearance of spine, even today depends on nature of the book itself—how thick it is, etc. The other factors which have some effects on the shape of spine are nature of the paper (its flexibility, thickness) type of sewing (whether it is done with thick or thin thread) etc. If the book is very thin rounding off of the spine is not necessary. Generally the book whose spine is repaired or where thick thread is used for sewing, spine becomes thicker ; to avoid this, for repair of spine area, strong but very thin Japanese tissue paper can be used and

Rounding of Spine



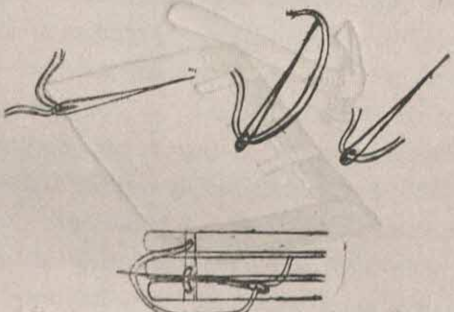
I Proper rounding of spine to hold the cover IIA Inadequate rounding. IIB Excessive rounding. IIC Proper rounding. III Use of hammer for proper rounding.

spine can be kept in its original form with light hammering at the time of repair. One of the preconditions of good binding is that the spine should not be unnecessarily thick and heavy.

Sewing : It is convenient to have sewing after fixing the book on frame which is arranged permanently for tape or cord sewing. Depending on thickness of the book, the crossbar can be lowered as required. At the time of sewing care should be taken to see that the tape or cord is tight enough to make the binding strong.

Sewing can be of various types—each one serve some specific purpose—someone is suitable for thick, other one for thinner and some others for weaker books and so on. Some of them are very strong and durable, where as other are not so durable. Certain type of sewing requires appreciable time and efforts and naturally the result obtained is very durable binding, whereas there are others, which is just the reverse. It is not possible to discuss here in detail about various type of bindings, therefore let us discuss in brief about some important type of binding. In case of thin books or pamphlets sewing is done with three or five and sometimes more holes. The thread is pulled tightly and a reef knot is used to hold the middle thread down. This type of sewing is done in case of less costly ordinary books. In

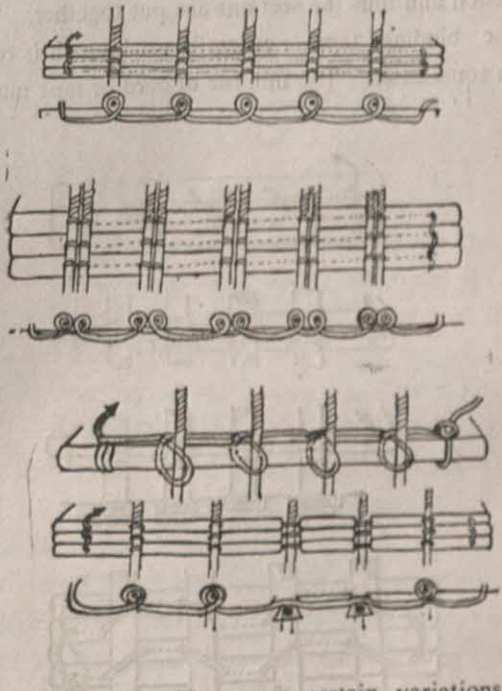
Proper use of needle for sewing



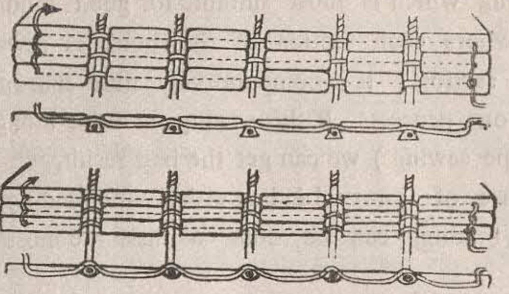
this type of sewing the book cannot be opened flatly and when opened the spine is subjected to certain amount of pressure which may damage the book if the leaves are thin and weak. The sewing which is most suitable for good binding is french sewing, where each section of the book is sewed with its adjacent section ; it is comparatively time consuming as well as laborious process. If this sewing is done along with tape (i. e., tape sewing) we can get the best result.

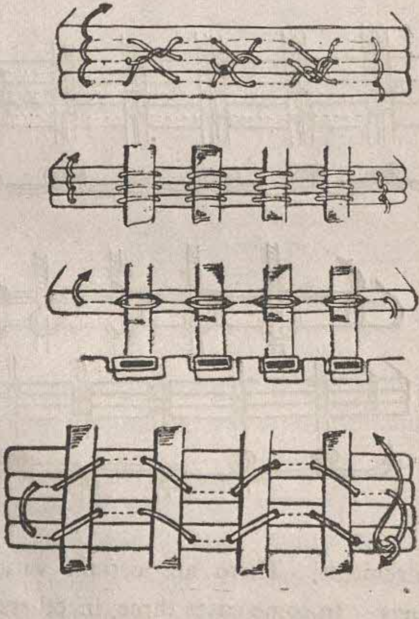
In case of library binding either tape binding or modified french binding can be done as these are most suitable for

Different types of sewing

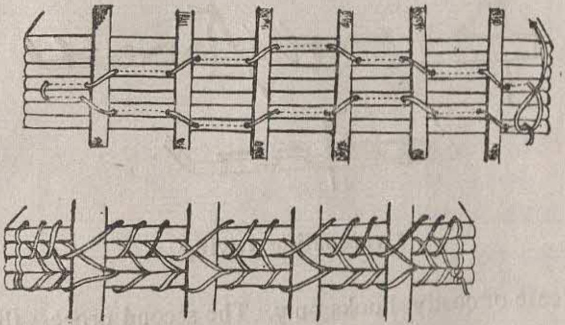


library requirements. There are certain variations of these type of bindings. In some cases three, in others four sections are sewed together. For this type of binding generally long thread is taken in the needle so that with six or eight or more stitches are made on each section and the thread moves to the next section and thus the sections are put together. To strengthen the binding tape is generally used which is replaced by cords in some cases. The number of cord or tape may be two or more. Whatever may .be their number they are placed on



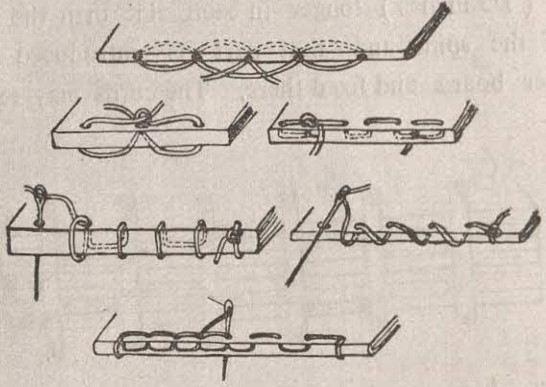


the spine parallel to the top edge of the book and at equal distance from the edges. The main function of these are to hold the sections as well as the covers strongly against the book. Therefore the length of tapes should be about 3·75 cm (1·5 inches) longer in each side than the measurement of the spine and that part is introduced through the cover board and fixed there. The cords may remain on



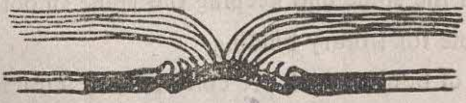
spine in two ways—in one case it remain above the spine causing slight swelling on the same, and in other case, it remains within grooves cut out on the spine making the same smooth. But in the later case, paper on the spine edge becomes weaker and the sections easily comes out if the thread gives way for some reason or the other. But still, the later system is more used due to the reason that it makes it convenient for rounding off the spine and keeping the spine smooth. But it is not preferable for library binding.

In case of books which are collection of loose leaves instead of folded sections or which have folded sections with very weak portion at the region close to spine, it is not possible to have tape or french sewing., This problem can be solved in two ways – firstly the portion close to spine can be strengthen by using Japanese tissue or other thin paper and then tape sewing can be done. In this case spine may swell up, if Japanese tissue is not used and mild hammering of the spine is not done. This process is time consuming and costly ; therefore can be



Overcosting sewing

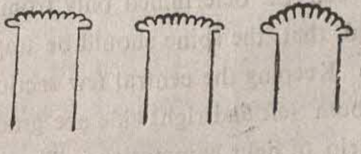
used in case of costly books only. The second process that can be utilised, is overcasting sewing. For this type of sewing thin but strong thread is necessary and if possible the holes should not lie more than 3 mm (1/8 inch) from the edge, otherwise opening of the book will be restricted. In no circumstances books with overcast sewing can be opened as flatly as the books with french or tape sewing. The sheets are separated into groups of six of eight leaves and each group is put together with overcast sewing. Then such separate groups or sections are sewed together by using tape or cord sewing. This type of binding with overcast sewing requires proper application of adhesives on the spine which also help to keep the pages together.



Books with French Sewing ean be opened flatly

Preparation of the spine : After the sewing is over, slightly diluted flexible adhesive should be properly applied to the spine so that it is properly covered with adhesive and also the sections can be hold together as a result of its application. Before the adhesive is fully dried rounding of the spine is to be done with help of light hammering. But before these steps can be taken the pages of the books should be cut with the help of cutting machine. Care should be taken to cut the minimum required portion so that the size or the symmetry of the printed pages are not effected. At the time of cutting, the book should be properly fixed in the machine. If the paper is very weak or the cutting blade is not enough sharp the cutting cannot be uniform. Therefore before actual cutting these aspects should be examined. If the book is placed between two boards at the time of cutting, better result can be obtained. The covering boards used for cover, should be slightly bigger than the actual size of the book. The guillotine type of cutting machine is costly, but as it gives best cutting, preferably this should be used. But to get the best result from guillotine machine adequate and uniform pressure should be applied at the time of use.

Rounding of Spine

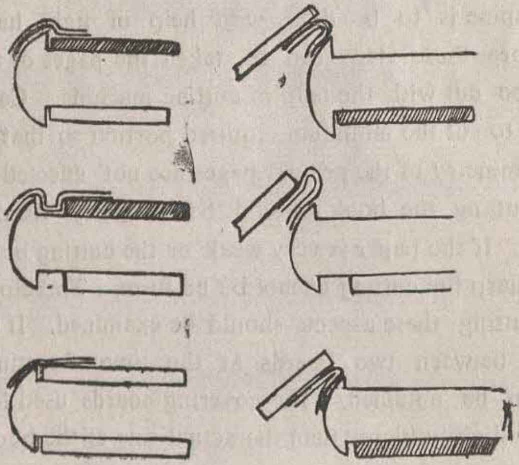


Improper Rounding

Proper Rounding

Other than proper sewing, the factor on which good binding is dependent is proper rounding off of the spine. Those books which do not have rounded spine, though do not create problems at the time of use, it becomes weak when kept standing on the shelve, as due to gravity the leaves trends to come out and move away from the spine creating serious pressure on

Flexibility of Various Binding



Top—Publishers binding, Middle—Library binding,
Bottom—Flexible binding.

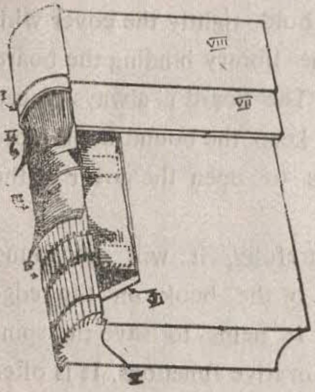
the tape or cord, which may ultimately be damaged. In case of rounded spine the pressure is spread uniformly on all the part of the spine decreasing possibility of any such damage. The amount of swell can be determined only from experience and this can be said that the spine should be approximately one third of a circle. Keeping the central few sections undisturbed, the sections on both left and right side are gradually bent outwards with the help of light hammering. The proper pressure and style of hitting is determind through experience. Various steps are shown in the diagram. If rounding is less or more than required amount, that will be damaging for health and durability of book. If rounding is more, it become difficult to open the book properly. In case of thin book, rounding of spine is not possible.

The thickness as well as hardness of the board for cover is dependent on the thickness and weight of the book. In general for publishers binding it can be said that the thickness of the board should be 1/3 of the maximum height of the spine from the first section ; this helps to hold tightly the cover with the covering cloth. In case of the library binding the board selected will be of thicker type. The board is always placed slightly away from the spine to keep the bound book more flexible and the groved formed helps to open the cover of the book without any difficulty.

On examining bound book carefully, it will be found that on the top and bottom end of the book on the edge of the spine headbands are fixed. It helps to save the spine from damages in addition to its decorative functions. It is often found that some readers are bringing down books from the shelves, by pulling the spine portion of the cover of the book. This is a very damaging habit. If the book is provided with strong headbands, that will provide some resistance to such damages. Headbands can be of various types : these have also changed in form during various ages. It takes both time and efforts to prepare a strong and durable headbands. These type of bands are sewed to the spine with help of fine silken thread (specially in case of library binding). Sewn headbands are not only decorative but also constructional, as books are occasionally removed from the shelf by any indiscriminate finger hooked under the head-cap, resulting in torn leather at the head. Readymade headbands are available in the market which are pasted on the position in case of cheap publisher binding ; they are only of decorative use. Sometime cord covered by thin leather is also used as headbands.

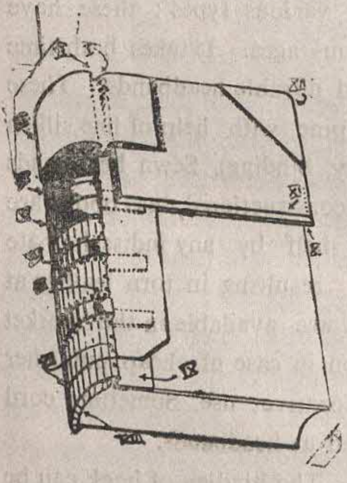
Different stages for binding : The binding of book can be broadly divided in three types e. g., case binding or publishers binding ; library binding and flexible binding, which can be of two types—smooth spine and spine with raised cords. Similarly library binding can be also of two type—cloth and lea-

Publishers Binding



I. Stiffener (not attached to spine), II. Second lining (kraft paper), III. First lining (mull), IV. Sewn on tapes, V. Joint, slightly thicker than the board, VI. Cut away waste sheet, VII. Straw-board, VIII. Cloth cover.

Library Binding

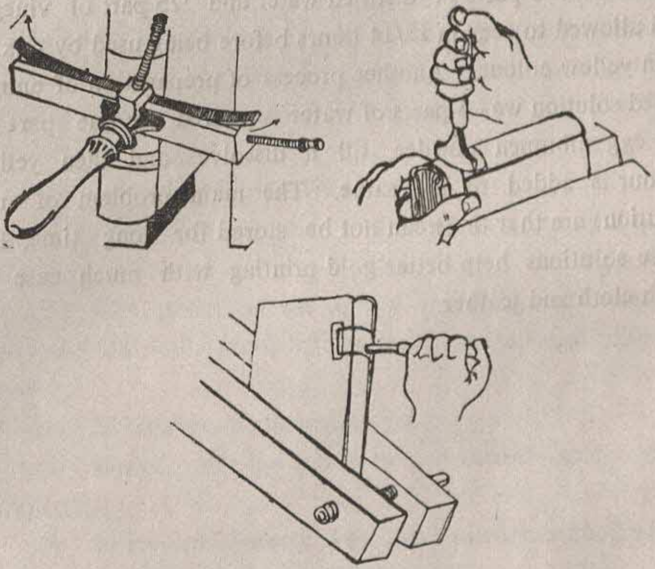


I. French groove, II. Extra leather at hinge, III. Tight back, VI. Second lining (kraft paper), V. First lining (mull), VI. Sewn on tapes, VII. Reinforced sewing, VIII. Overcast first and last sections, IX. Reinforced endpaper, X. Wide Squares, X1. Split board, XII. Rounded corners, XIII. Inserted cord.

ther binding. To make the differences of these types of binding more clear, different stages of the same are given in the ensuing comparative study.

The lettering on spine to indicate author, title etc., of the book is done in various ways depending on the type of binding. In case of publishers binding this is done before the book is inserted in the case. But still some basic rules are to be followed in this job. The writing that is to be done on the spine and cover, will be clearly written on a piece of paper. Due to availability of very limited space on the spine, abridged/shorter title will be written e.g., in place of full title of "Library Administration with special reference to third world countries" the shorter title "Library Administration" will be written on the spine. The writing will be from top downward.

Different Stages of Lettering on Spine



After writing distinctly the name on bond paper which will be placed in the appropriate position and the gold foil will be introduced below the same with golden side upward. Now the types for printing will be slightly heated on the holder and when the same is heated to appropriate temperature with mild pressure the printing can be done perfectly. But in case of lower temperature both time as well as pressure required will be higher and in case of too hot types the cloth or leather will be damaged. The appropriate temperature can be ascertained through experience, but it can de said that the best temperature range is from 79° to 90° C and if a drop of water is dropped on the holder, it will evaporate slowly.

In case of gold lettering on leather binding the appropriate portion will be determined and a light impression will be made with warm types (this can also be done with cold type with moderate pressure). Then that portion will be made ready for printing with help of a solution which is generally prepated with lacquer. This type of solution is popular now, as it is convenient to use, as well as it can be stored for much longer period without any damage. In earlier days solutions of animal based proteins are used in which 1 part of egg albumen was mixed with 2 parts of distilled water and ·75 part of vinegar and allowed to remain 12/14 hours before being used by mixing with yellow colour. Another process of preparation of animal based solution was 4 parts of water is poured to one part of dry egg albumen powder, till it dissolves and then yellow colour is added to the same. The main problem of such solutions are that these can not be stored for long time. But these solutions help better gold printing with much ease on both cloth and leather.

Administrative Aspects of Library Conservation

The conservation problems and requirements differs from one library to another, which depend on its size, its collection, policies of the library etc. Therefore every librarian should plan his own conservation section/department keeping in mind about his own requirements and resources. A library devoted to old religious, historical literatures, manuscripts etc., have quite different conservation requirements than a library devoted to some brance of modern science e.g., nuclear or space sciences etc. But it is true that there are some aspects of conservation which are common in all the libraries ; but special requirements varies from library to library. The collection and its use also effects the conservation requirement indirectly.

Before taking any decision about conservation department, it is necessary to study the following aspects of the library closely—

(1) Size of collection—big or small ;

(2) Percentage of old materials (e. g., manuscripts) in the total collection ;

(3) The policy of the library regarding old collection—whether old publications are preserved or replaced with newer ones ;

(4) Borrowing is allowed or not ;

(5) Usage of the collection — considerable/moderate/negligible ;

(6) Users are mostly research workers/students/general readers, who prefers light reading ;

(7) Collection contain one type of material or various type of materials ;

(8) Condition of the collection (e.g., if its main section (major portion) is weak and considerably damaged).

If this study is done with adequate care then it will be easy to assess the type of conservation department that is necessary. We will have to consider certain aspects closely keeping future requirements in mind. At this stage, if it is possible to take advise from any conservation expert, it becomes an asset, in case of long range planing. Also if the recommendations of the expert can be obtained in a report form, it becomes easier to convince the higher authority to take a decision, specially in matters connected to finance or appointments of fresh workers etc. We can utilise the services of experts also in form of arranging speeches, lectures etc., to motivate the workers by giving them exposure to latest developments in the field of conservation.

The library building and its inner environment plays a vital role in conservation efforts ; as on this physical condition of the collection and future possible deteriorations depends. As an example, it can be said that in a city area, if a big library is housed in a old building, its problems of conservation will be more, than that of a medium sized library housed in a fully air-conditioned new building. The age of the building, its floor plans, shelving and storage condition of the collection, air-conditioning arrangements, ventilation/ air circulation systems etc., effects the conservation efforts to a great extent directly. Therefore, the requirement aspect is very important factor in planning the conservation department.

The policy followed by the library is also important factor to effect the decision to be taken. If the library is attached to an organisation, the parent organisations policy will effect the policy of the library also. At the time of planning, we will have to remember the aim and objective of the library. Those libraries which have branches or which are spread over more than one campus, have some specialised conservation problems of their own. In a library, if the conservation department is going to be introduced for the first time, we will have to find out how the works connected to conservation e. g.; binding etc., were done previously, as that factor is also important. As for example, if the library have taken a policy to have micro-film of old newspapers instead of preserving them, then the conservation policy will be different than that of preserving old newspapers. If the library have a policy to purchase cheap paper back editions, then the problem of binding will be huge. We have to study also, the actions taken so far regarding the weak and damaged books.

After full evaluation of total collection, defects of the library building, effects of present and future environment etc., we will have to take decision about the conservation department. The plans can be implemented properly only when the library management and all library staff proceeds to implement it jointly. When each and every staff understand the necessity and importance of every step, then it becomes easier to get the cooperation from all section automatic, instead of something imposed. The priority of every step should be determined, as in case of different libraries it differs, as they are dependent on condition of library building, collection, environment etc. The field of conservation is very big and in one way it can be said that there is no end to this job and that is why fixing of priority is so much important. At the time of doing this, it should be kept in mind that those works/processes which are important and whose effects can be obtained immediately, should get priority over those jobs which takes long time and whose effects will be available slowly. Another major problem in countries like ours (i. e. developing countries) is the limited availability of funds. In most cases only fraction of total required fund is available. Therefore costly processes/equipments (even if they may be very effective) should be avoided as far as practical and we should try to reduce, if not stop altogether, the deterioration of library collection with minimum possible cost.

Every library job and its direct or indirect effects on conservation should be studied closely, as from this it will be possible to determine the long range processes to be followed. Each and every action that stimulates deterioration in library should be rectified or stopped. Starting from the efforts to reduce the deteriorating effects of the environment (e. g., to ensure that sunlight do not enter the library by using curtain or colour glass-pans etc.), making library staff conscious about conservation through training, film-show etc., all these come under the conservation efforts. Similarly many ongoing processes such as, binding, lamination, repair or deacidification etc., are inseparable parts of conservation. If some material becomes very weak and cannot be repaired or restored, it can be copied or recorded on other medium (as for example, to get microfilm prepared for almost destroyed manuscripts etc.), that is also a form of conservation.

The centralised conservation department should be planned considering the library's size, collection, policy etc., so that the works related to conservation of all other departments can be done here. In other system each department will perform their job as per the standard and direction of main conservation principle of the library. The effective conservative measures are as varied as the conservation job itself.

Whatever may be the conservation plan, it should be controlled in such a way that no problem can arise in its implementation. Practically it is difficult to organise a centralised conservation department in a very big or very small library as the conservation job is connected to so many different works (e. g., from security arrangement at the entry/exit point of the library to preservation of specialised materials like video cassette etc.) that it is next to impossible to bring all of them together under one roof. Therefore the main responsibility comes over to the librarian to determine the policy of conservation. Under this circumstances, the best policy is to enumerate a comprehensive conservation policy and to divert the job of restoration and repair etc., to a full-fledged department under expert guidance. The expert should help conservation requirements of different departments and advice them as and when necessary. The conservation department is not self-sufficient like cataloguing or similar other departments. The success of the department is therefore depends on active cooperation available from all library staff and users and also from various other departments.

The conservation department cannot develop properly, so long the necessity of this work is recognised. Before the department is started, all the library staff should be made conscious about its function and its essential requirements for maintaining a healthy library.

Once a decision is taken to open a conservation department, the next important question that comes up, is how much (what percentage) fund we should spend for this purpose. There is no necessity to spend a lion share of the total budget on it. Spending on the basis of the ability of individual libraries with active attempts to restrict and delay the deterioration of library materials is important. Even before starting a separate conservation department, every library is spending some fund in conservation work e. g., binding of old and damage books, binding periodicals etc. When these works are centralised in one department the jobs can be done more effectively and in a better way. In addition to this, the possibility of expanding conservation efforts in future also increases. At the initial stage a committee can be formed to examine the collection to advise the requirement of restoration and repair etc. Effective result can be obtained by following the recommendations.

It will not be a wise decision, to undertake a full-fledged all out effort for conservation in a economically backward developing third world country like ours. We should start our work from preventing or restricting deterioration and then, can gradually proceed to other aspects as the necessity of fund and equipments is comparatively much less in this job.

In those libraries, where fullfledged restoration and repair works are undertaken at a time, the fund necessary for appointing suitable staff and other administrative cost becomes more than the cost of equipments and allied materials. The final result becomes such, that though the department is started, most of the posts are left vacant due to shortage of fund.

In some cases it is possible to manage the functions of the department by arranging short time training to enthusiastic workers. Most of them work with renewed interest in these new posts and responsibilities. In some cases by engaging commercial firms for specific jobs (e. g., pest control etc.), we can have the work done at a lower cost. But there is always scope for further improvement in due course.

The main financial responsibility of the conservation department are staff salary, cost of microfilm, microfiche, etc., for conservation of rare collections, cost of equipments, chemicals and other materials for restoration and repairing work etc. Some of the cost, related to conservation department, are included in the budget of other departments, as for example, the cost of reprography is not included generally in the expenditure of conservation department. If the library is a part of some bigger institution, the general maintenance of the library building, fire prevention system, airconditioning systems are normally included in the budget of the parent organisation. This arrangements have some disadvantages also e. g., if it is necessary to make some addition/alterations in the library building, it will be necessary to convince people of the parent organisation before the job can be completed. This is not an easy job and becomes still more difficult if the higher management of the organisation is not alert and sympathetic about the requirements of the library. As for example, it is a proven truth that the best temperature for library preservation is 22° to 23°C (70°F), but it is very difficult to convince the higher authorities to maintain that temperature within the library building.

The cost of conservation increases due to negligence e. g., if books are properly kept on the shelves and handled carefully, they will not be damaged easily and therefore there will not be any necessity for fresh binding. In those libraries where incoming books (both newly acquired and returned from circulation) are allowed to remain on the floor, the physical conditions of books deteriorates quickly. These incidences increase the cost of conservation. Therefore it can be said that preventive measures against deterioration of library materials will help to keep the conservation budget within a reasonable limit. The library collection includes many important and rare materials which are part of our rich cultural heritage, this fact should always be kept in mind and appropriate steps should be taken to preserve them.

The main functions for conservation department are as follows (1) Formulation of the conservation policy ; (2) Proper plans should be made to face sudden natural calamities or accidents ; (3) Formulation of standards for environmental control, its planning and proper implementation ; (4) Proper monitoring of environmental conditions ; (5) Proper conservation of information (e. g., rare and valuable publications should not be allowed to be handled by general users) ; (6) Arranging photocopying systems including microfilming, so that researchers can have the information/documents of their requriement without handling the weak/rare materials. In this respeet cooperation from other libraries of the same locality can also be utilised ; (7) If necessary, to have agreements with commercial firms for doing microfilming jobs, (8) Cooperating with the microfilming and reprinting organisations ; (9) Fixing the standard of library binding and if necessary to contact appropriate firms ; (10) Arrangements should be made to fix mass deacidification standard and necessary steps should be taken for implementation ; (11) Establishing inter-library cooperation in the field of conservation based on actual requirements ; (12) Establishing definite policy for use, exhibition etc., of the rare and important collections of the library ; (13) Starting various plans and programmes to make the library staff and users aware and conscious about the importance of conservation and its different aspects ; etc.

The restoration and repairing job of this department include —(1) Application of fumigation process ; (2) Placing of books on the shelves in proper manner ; (3) Selection and separation of books that require binding ; (4) Binding of pamphlets for preservation ; (5) Cheap repairing of general books ; (6) Fine and exclusive repair of rare publications ; (7) Selecting appropriate quality of leather for use ; (8) Preparation of protective folders ; use of encasement and utilisation of advanced restoration methods ; (9) Utilisation of encapsulation system ; (10) Introduction of conservation system for those materials for which no such arrangements are available now ; (11) Arrangement to improving physical condition of the library materials whenever necessary ; (12) Utilisation of leather preservative mixture whenever necessary ; (13) Arranging binding of new books ; (14) Deacidification ; (15) Repairing and binding of old collections ; (16) Rebinding for conservation ; (17) Documentation—whenever necessary ; (11) Application of advanced technology ; (19) Utilisation of reprography system to assist the conservation jobs ; (20) Proper arrangement of preservation of plastic based or similar materials (e. g., microfilms, micro fiche, video tapes etc).

Various type of staff that may be necessary for conservation department include—(a) Professionally qualified librarian ; (b) Professionally qualified conservator ; (c) Semi-skilled library staff ; (d) Conservation technicians/chemists ; (e) Binder ; (f) Helper ; etc.

Other than general office room for working, full-fledged conservation department must have a laboratory and workshop.

Public libraries, school or college libraries do not require to have a full scale conservation unit. But it is essential for a very big library with a collection of rare and valuable manuscripts of appreciable size, which can be considered to be a part of our national history, cultural heritage and of national importance The primary important works of such department are—(1) Prevention of deterioration of physical condition of books, periodicals, documents etc., so that they do not become brittle ; (2) Restoration of brittle or almost brittle materials and their repair ; (3) Restoration of water damaged materials ; (4) Protection of library collection from attacks of insects, fungi etc. ; (5) Restoration of faded, dirty and other documents which have various stains on them ; (6) Protecting the collection from various natural calamities as well as accidents like fire, flood etc ; (7) Protecting the collection from the effects of deteriorating environments ; (8) Overall protection of the collection from all type of deterioration through restoration and repair ; etc.

To perform these duties effectively a laboratory cum workshop is essential. If such laboratory works under the able guidance of experienced professional technician, the ultimate effect obtained will be the best. Through proper utilisation of modern technologies in the laboratorie, it is possible to determine components of the materials, their conditions, presence of damaging materials in them and their probable effects on the same and possible preventive measures against the same, etc. Apart from these, there is necessity of a well equipped restoration workshop and suitable repairing laboratory and an efficient bindery. The presence of a effective reprographic section is also equally important from the conservation standpoint.

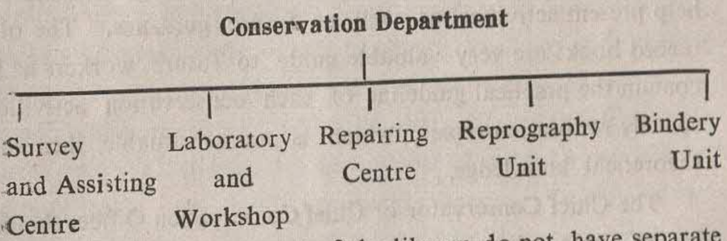
After finding out what are the essential departments, now let us find out what should be the size of such departments. The best possible reply to such a question, is that, the size will depend entirely on the quantum of job to be handled, which can be determined through survey.

The total number or percentage of books which require restoration (e. g., deacidification, fumigation, controlling humidity, preservation of leather used in binding etc.), repair (strengthening of paper through lamination) binding should be determined and wherever necessary help of other facilities e. g., reprography etc., should be taken. Through survey it is also to be determined that how much job should be undertaken immediately and what will be the pressure in future. After careful study of the survey report shape and size of the department will be determined. Once a decision on that respect is taken, it will be easy to decide the total number of staff and type of staff e. g., chemists, binder, skilled or semi-skilled, and their departmentwise distribution etc.

Different types of chemicals, equipments are required for different works—a list of those materials should be made depending on the actual necessity and probable use. In case of some materials, we will have to depend on our ability to assess future requirements.

Depending on the workload and on other environmental factors, some changes in the work area may be necessary e. g., arrangement of adequate air circulation, creating a dust and dirt free environment etc. These changes or addition and alterations should be completed at the time of establishing the department.

But most important aspect of total planning is to determine the financial requirements – i.e., to find out how much fund is required for smooth functioning of the department, including initial cost of equipments, as well as to keep the ongoing jobs continue without any difficulties. If it is found that it is not possible to get the full finance at a time, then we will have to implement the programme on phases according to priority of the Institution.



As in our country most of the library do not have separate conservation unit or facilities that is required for conservation, it is often found that requests are made to libraries with such facilities from neighboring as well as from libraries of other places, for help in this field for conservation of their very weak or damaged valuable collections. In all such cases, we should extend our helping hand as far as practicable, keeping in mind the greater interest of the country. Financial implications of such activity should also be kept in mind. At the time of planning conservation department this aspect should also be considered. All units and sub-units of the conservation department must have extensive coopetation among themselves as well as with all other departments of the library and that will ensure a perfect working atmosphere.

All the staff of this department should be of responsible nature and committed workers. Whenever any book, manuscript or document reaches the department, it should be considered as a valuable material and should be kept properly. Whenever it is necessary to shift such material from one unit to other, that should be done after keeping proper movement record by maintaining a movement register. This system not only help to avoid misplacement of materials, but also help to indicate the condition of the material and its proper location and the stage of its repair/restoration etc., at any point of time. This system also helps to avoid misunderstanding with other departments. Except the movement register the department should maintain a record book, in which the steps of different processes, its applications and the results will be recorded to help present activities as well as future guidance. The old record books are very valuable guide to future workers as it contain the practical guideline of each conservation activities specilly restoration/repair, which is more valuable then the theoretical knowledge.

The Chief Conservator or Chief Conservation Officer should be an able administrator. His administrative ability will prove more valuable asset than his technical expertise, as he will have to deal with technical experts and skilled workers, who have enough knowledge about their own subject but have little conception about work in other units or departments and this may often lead to misunderstanding and generation of strained relation, between different departments and units. This is generally caused from the fact that experts can understand problems of his own field easily, but fail to appreciate readily difficulties of other units. The head of the conservation department i.e., Chief Conservator can play a very important part in this respect to defuse tension. His proper leadership will ensure a ideal work-atmosphere. He should have a broad outlook and a never ending thirst for knowledge—he should keep tract with newer researches and developments as well as discoveries in the field of conservation in the country and abroad. He should make arrangements to convey these information to the experts and technicians, so that they can also keep abreast of latest developments and can use the latest techniques for benefit of the library and also improve the quality of their end-products. In case of necessity direct contact can also be made with research organisations abroad to have latest information within a short time. As newer technologies are coming up in the field of conservation, these effort to keep up-to-date information, will help to perform their duties more effectively.

The responsibility of the Conservation department is very high. All jobs should be performed with adequate care and nothing should be done in a hurry as even a slightest mistake may lead to serious damage or even destruction of irreplaceable materials, which is part of our national heritage. All the duties in this department should be performed in cool brain and with adequate thought. It should be ascertained before using any chemical, that the same will not damage or weaken the material in any form. Before doing any repair or restoration work, a copy (xerox or photocopy) should be made so that, even inspite of all precautionary efforts if the material is damaged, we can have atleast a replica of the same.

We have already seen that conservation department may have about five units or divisions under it (in a medium or smaller library two or more units may be joined to form one unit). Let us now find out the functions of each unit.

Survey and Assisting Unit

The main function of this unit is (1) to ensure that proper atmosphere suitable for conservation is maintained within the library premises ; and if necessary rectifying steps will be taken ;

(2) The materials which are damaged and require proper restoration/repair etc., will be send to appropriate units ;

(3) Give advises to different departments about conservation ;

(4) Survey of this unit will include—proper illumination,

air-circulation, position of books and other materials on the shelves, dusting arrangements, proper use of insecticide/fungicides and protection from the attack of other damaging and deteriorating factors ;

(5) If air-conditioning system is installed in the library—to check its proper functioning in all aspects ;

(6) Proper functioning of all equipments (including those which are in use in conservation department) and if necessary ensuring their repair or maintenance by appropriate authorities ;

(7) Taking every efforts through checking of electric wiring, water supply line etc., to avoid any possibility of accidental damages.

Laboratory and Workshop

The main functions of this unit include deacidification, fumigation, application of leather preservative mixture, insecticide, fungicide, preparation of various materials and chemical compounds e.g., adhesives, preservatives etc.. for the collection which are forwarded by the Survey and Assisting unit for repair etc. Other than these, the suitable method for restoration of the damaged books/documents are determined through scientific experiments, which include analysis of the materials. These examinations will help to identify reasons of deterioration (caused due to presence of certain elements which may remained embedded within the material from the time of its manufacture and also due to polluted environment).

Apart from these, to find out more effective new processes for restoration and prevention of deterioration, research and experiments should be carried on. In case of necessity cooperation with other institutes can also be made. In certain cases experiments and research studies are made on effects of various chemicals on different types of insects, instead of studying library materials. These studies also often become very useful from conservation standpoint.

Basing on acquired experience and knowledge this unit can help other departments and units through advice and technical assistances, so that they can achieve better result at lower cost to maintain library collection in perfeet condition.

Special Repairing Unit

The main function of this unit is finer repairs, which are more delicate and time consuming, and need more technical expertise and experience. It may so happen at the time of work, some new problem may come up for which no ready-made solution is know, but through trial and error some kind of solution is found out. The functions of this unit include strengthening weak and brittle books, documents through lamination, re-lamination of materials which were laminated once—long back and the same became weaker due to various environmental reasons. Depending on the condition, decision should be taken to strengthen the collection by appropriate means e.g., mounting, encapsulation etc. Due to deteriorating factors (e. g., increase or decrease of moisture etc.) if outer physical condition of the material have undergone change, attempts should be made to restore them to original condition. Special conservation arrangements for water damaged or fire damaged materials are made here. To facilitate these jobs, different types of equipments, e.g., vacuum chamber, fumigation chamber, lamination machines etc., are used. It is preferable to have an expert, as head of this unit ; where as the staff should be experienced, skilled workers. Special repairing jobs are both costly as well as time consuming. Therefore, the head of the unit should consider all aspects and select only those materials which are valuable and rare, on priority basis for repair, as the financial resources are not enough to handle special repair of all damaged materials

Reprographic Unit

In several cases the materials may be damaged to such an extent that their restoration become uncertain or almost impossible, in such cases help of reprography can be taken to to protect the information recorded in them. This unit, with assistance of the advisory team, can prepare a list of materials for which copies are to be made and work accordingly. Depending on necessity this unit will do other urgent library jobs as and when necessary e.g., preparation of microfiche/microfilm of newspapers etc. Apart from these, they will also produce photocopies of articles or part of books on the basis of requisitions received from the research workers or library users. Normally microfiche/microfilm etc. are kept under custody of this unit. This unit have various equipments for their work e.g., plain paper copier, microfilm/ microfiche camera, processors, microfiche microfilm reader-printer etc., also with suitable darkroom and laboratory for processing films etc.

Binding Unit

This unit undertakes job of library binding for all the materials which are damaged due to constant use or some other reasons. Small repairing jobs which are required to be done before binding are handled here.

The periodicals which are subscribed by the library are normally bound in one or more volumes, as the case may be, to facilitate storage and conservation. All materials used for this purpose (e.g. board, cloth, leather, thread, adhesive etc.) must be of good quality and if required should be checked in the laboratory to find out if it is of required standard or not.

Other than routine binding jobs of materials selected and forwarded by the Survey and Assisting Unit, the function of this unit include the job of keeping a close watch on the library collection to find out materials which need small repairs and can be revived its physical condition with small efforts and cost, and separate them for necessary jobs to be done. All books do not require same type of binding ; therefore decision are to be taken on individual basis after examining each material separately and evaluating its requirement. Exclusive type of binding should be done for rare and valuable materials. For ordinary text books, which are available in the market, ordinary cheaper type of binding should be done to keep the same usable for some more time, after which these can be replaced by fresh copy (may be new edition), as these materials do not have any long lasting or historical value. Binding materials as well as the equipments are procured and are kept under custody of this unit.

The publications on which investing for fresh binding is not worth-while or with the cost of binding, if a fresh copy can be procured, it is the duty of the unit to draw the attention of the library authority on those matters and help them to take a decision on such matters like weeding out those materials. The head of this technical unit should have a very good knowledge about binding and its various aspects and staff are skilled binders and semi-skilled workers.

It may seem from the above discussions that the units are fully independent, but in actual field it will be found that all of them are interdependent. Therefore best result can be achieved only if all the units work together with fullest cooperation among themselves.

The staff position (e.g., total number, type of worker etc.) are dependent on total work load as it varies from library to library depending on their size, nature etc. But if we know the approximate performance of one single worker, it helps to plan the staff structure basing on that.

In one working day a worker can deacidify about 400 sheets ; or repair (general) about 120 pages ; or Special repair with tissue paper about 60-70 pages ; or Sizing 400 pages ; or Guarding 480 pages ; or Sewing 640 sections ; or Tooling 2-3 books for binding ; or Repairing 80-100 pages with cellulose acetate, acetone foil and tissue paper, etc.

For each medium capacity automatic copier one skilled worker and a semi-skilled worker is necessary. For two such machines three skilled workers are necessary to operate the machine and do other necessary jobs which are connected with these. In case of a single machine if the copy output is over 700/800 copies per day, it will be necessary to have two operators.

Let us now discuss another important aspect of reprographic unit, which is related to copy cost, that will be charged from the users. In this regard, we will have to consider several aspects. e.g., cost of various materials and activities, as for example, the costing will be—

Cost of paper (if ream cost is Rs. 50 00)	10 paise
Tonner/developer	8 paise
Electricity etc.	2 paise
Depreciation/maintenance	20 paise
Total	40 paise

Normally an automatic copier gives very good service during first two years after purchase ; during and more specially after that period it requires occasional servicing and after five years the cost of repairing goes up to very high side. As these machines are made up of very fine parts and therefore even the best machine should be supported by very good after-sales services. Any after sales service can be considered to be good, if the maintenance engineer or technician help to revive the machine to usable condition within short time (say one or two days depending on the distance of the service station). But unfortunately in developing countries like ours, the after-sales service aspects are most neglected. Companies take more interest to sale machines than to keep them in workable condition. But there are one or two exceptions also, e.g., Modi Xerox Limited who have a excellent support of such service. At the time of selecting any machine special care should be taken to ascertain good after-sale service. In this matter help from other libraries, who have installed any such machine earlier, can be taken ; as no manufacturer or distributor will accept that their service is not good enough ; but this can only be determined from actual experience of the users.

The conservation job requires various types of materials and equipments—list of some such materials are given in Appendix A and B.

Observations and Suggestions

Library collection is an important national property which cannot be separated from our social and national heritage. We have to take adequate care to see that these materials are preserved in perfect condition for the future generations. In our country we have numerous libraries which have (chiefly the older ones) very valuable and old/rare collections that are gradually getting deteriorated due to improper and inadequate conservation arrangements available.

In this respect, it is our earnest request to Government of India, all State Governments, Indian Library Association, Indian Association of Special Libraries and Information Centres, all professional bodies connected with libraries and information sciences, general public, who love libraries and above all to all conscious readers :

1. Continuous efforts should be made to make people conscious about conservation of library collections.
2. One full compulsory paper on "Library Conservation" should be included in all library science training courses atleast at the certificate and degree levels, in India.
3. National Archives of India and National Library should take initiatives to organize both medium and short-term regular practical training courses in every regions, if not in all the states. In this connection the State Archives and State Central Libraries can also play an important role.
4. In all the states, the central libraries (in absence of it, the most important library of the state) should have

full-fledged micrography unit (with all facilities including micro-filming, etc.) ,and a well equipped reprography unit.

5. It should be made obligatory to have a well equipped conservation unit for all libraries which have appreciable number of manuscripts or similar documents in their collection. The State and Central Governments should provide required assistance to start such unit, wherever necessary.
6. Some type of practical training programmes should be initiated by State Central Libraries and State Archives to train up people working in different libraries.
7. Depending upon actual requirement each library should appoint necessary professional staff for proper library conservation.

Appendix A

Some Essential Equipments

1. Glass top tables for each worker engaged in repairing job ;
2. Medium size hand press—45 cm × 61 cm (18″ × 24″) ;
3. Small paper cutting machine 40 cm (16″) or 61 cm (24″) ;
4. Big scissors 23 cm (9″) ; Small scissors 15 cm (6″) ;
5. Knife with long and sharp blade 15 cm (6″) ;
6. Bone folders, rampi or paring knives ;
7. Plates/cups/bowl made up of parcelain or stainless steel ;
8. Blant steel plate about 30 cm (12″) long ;
9. Bodkin ;
10. Small/medium/big needles suitable for sewing ;
11. Stainless steel or enamel tray ;
12. Pot suitable for preparation of adhesives ;
13. Electric iron ;
14. Medium size guillotine type cutting machine ;
15. Lying press ;
16. Nipping press ;
17. Electric heater or gas stove or kerosine stove ;
18. Ordinary air tight fumigation chamber ;
19. Vacuum cleaner and allied equipments ;
20. Equipments necessary for lamination ;
21. Atomiser/sprayers for spraying insecticides, etc ;
22. Hand sprayers ;
23. Almirahs for keeping chemicals and equipments ;
24. Long smooth wooden table, preferably with laminated top ;

25. Kipps aparatus ;
26. Balamer ;
27. Small hand-saw ;
28. Circular file ;
29. Awl ;
30. Light and medium size hammer ;
31. Ordinary soft brush both fine and medium size upto 4—5 cm (1·5" to 2") ;
32. Chisel ;
33. Big glass/porcelain or enamel jar of 25 to 30 litre capacity ;
34. Sink ;
35. Kettle for heating water ;
36. Thermometer ;
37. Equipments to measure humidity ;
38. Type holder for spine lettering ;
39. Eyelet tool for paper/leather ;
40. Equipments necessary for cutting and prepairing board/leather/cloth etc. for binding ;
41. Pots for keeping adhesives and other chemicals ;
42. Refrigerator ;
43. Incubator ;
44. Equipments necessary for emergency repair e. g., screw-driver, wrenches etc ;
45. Fire-extinguisher (Small, movable)—soda acid type, dry powder type, halon type, etc. ;

Appendix B

List of Chemicals and Other Materials Required for Conservation Department

Acetic acid
Acetone
Alcohol
Aluminium hydroxide gell
Alumina (activated)
Ammonia
Ammonium acetate
Ammonium sulphide
Amyl nitrite
Anthrecene
Arsenic trioxide
Arsenous oxide
Atropine sulphate
B. H. C. powder
Begon
Benzene
Barium carbonate
Bedacryle glycerin
Blotting paper
Board (Straw Board,
  Mill Board)
Borax
Boric acid
B[illegible] (activated)
Calcium oxide

Calcium arsenate
— carbonate
— bicarbonate
— hydroxide
Carbon disulphide
— tetra chloride
Carboxy methyle cellulose
Cedar wood oil
Cellulose acetate sheet
Charcoal (activated)
Chiffon (thin)
Chlordane
Chloroform
Cloth, for binding
—, cambric (starch free)
— — Longcloth
Citric acid
Clove oil
Copper sulphate
Creosote
Cupric arsenite
D. D. T.
Dettol
Dextrin powder
Dicapthon

Dimpylete
Ethyl alcohol
Ethylene dibromide
— dichloride
— oxide
Ferric hydroxide
Ferrous oxalate
Flour
Fluroglucinol
Formaldehyde/Formalen
Glycerin
Hexane
Hydrochloric acid
Hydrogen peroxide
Iodine
Lanolin (anhydrous)
Lead carbonate
— perchloride
Leather
Linseed oil
Lissapol H
Litmus paper
Magnesium carbonate
— bicarbonate
— sulphate
Malathion
Marbel (pieces)
Mercuric chloride
Mercurous chloride
Methyl bromide
Methylated spirit
Milk of magnesia
Naphthalene
Neatsfood oil
Nitric acid
Nylon glass (transparent)
Oxalic acid
Parachlorometacresol
Paranitrophenol
Pentachlorophenol
Paper, Craft
—, Japanese tissue
—, Marval
—, Handmade
Paradichlorobenzene
Perchloride acid
Petrol
Pip
Polymethyl methacrylate
Polythene sheet
Polyvinyl acetate
Potassium bromide
— ferrocyanide
— perborate
— permanganate
Pyrethrine oil (Pyrethrum)
Piridine
Rexin
Salt (edible)
Sandofix
Shelltox
Silica gel
Saffrol
Sodium bicarbonate
— benzorate
— carbonate
— hipochloride
— hiposulphide

Sodium hydroxide
— orthophenol phenet
— pentachlorophenol
— stearate
— sulphate
Tape
Tarpin oil
Tartaric acid
Thymol
Trichlorobenzene
Trichloroethene
Tannic Acid
Universal antidote
Vinegar
Wax (Beehive/Japanese)
Xylene
Zinc chloride
— ortho-arsenate
— phosphide
— chloro-iodide

Appendix C

List of Some Manufacturer/Suppliers of Several Equipments/ Materials Required for Conservation Deparment

High quality acid-free paper

Tribeni Tissues; 1 Lee Road, Calcutta-700 020

Air-Conditioners and similar other equipments

American Refrigerators Co. Ltd., 13C Russel Street, Calcutta-700 016.

Bajaj Electricals Ltd., V. Nariman Road, Bombay 400 020.

Blue Star Ltd., Kasturi Building, J. Tata Road, Bombay-400 028.

Electronics Ltd., 1 Tolstoy Marg, 7th Floor, New Delhi-110 001.

Fedders Lleoyed Corpn. (P) Ltd., 10/1 Kalkaji Extn., New Delhi-110 019.

Frick India Ltd., Jeevanvihar Building, Parliament Street, New Delhi-110 001.

Parry & Co., Deer House, Madras 600 001.

Spencer & Co., 769 Anna Road, Madras 600 002.

Voltas Ltd., 19 Graham Road, Bombay 400 001.

Dehumidifier

Arctic India Sales, 38 Block B, 3rd Floor, New Alipore, Calcutta-700 053.

Climate Control Services P. Ltd., 38 Sarojini Devi Road, Secunderabad-500 003.

Indian Equipment Corporation, Unit D/20, Udyog Sadan No. 2, MIDC, Andheri, Bombay-400 093.

Oriental Science Apparatus Workshops, Jawaharlal Nehru Marg, Ambala Cant. 133 001.

Raico Engineers, Unit No. 14-A, 1st floor, New Empire Industrial Estate, Kondivita Road, Andheri East, Bombay 400 059.
Udoy & Co., 6A Bhabanath Sen Street, Calcutta 700 004.

Close-circuit TV and allied equipments

BPL India Ltd., BPL Centre, 32 Church Street, Bangalore 2.
Beltek Electronics P. Ltd., A5 Ring Road, Naraina, New Delhi 110 028.
Bharat Television P. Ltd., 15 & 17B Technocrats Industrial Estate, Balanagar, Hyderabad 500 037.
Crown Electronics P. Ltd., Plot 88, DLF Industrial Area, 13/7 Mathura Road, Faridabad 3.
Electronics Corpn. of India Ltd., Industrial Development Area, Cherlapalli, Hyderabad 600 762.
Keltron Ltd., Vellayanbalam, Trivandram 1.
Maharastra Electronics Corpn Ltd., Plot 214, Backbay Reclamation, Raheja Centre, 13th Floor, Nariamn Point, Bombay 400 021.
Telerad Ltd., Saki Bihar Road, Chandireli, Bombay 400 072.
Televista Electronics P. Ltd., 239 Okhla Industrial Estate, New Delhi 110 020.
Uptron Electronics, Kanpur.
Videocon Ltd., Auto Cars Compound, Adalat Road, Aurangabad 431 005.
Weston Electronics P. Ltd., 244 Okhla Industrial Estate, New Delhi 110 020.

Photocopier and similar equipments

BPL India Ltd., BPL Centre, 32 Church Street, Bangalore 1.
Chougule India Ltd., 75 Park Street, Calcutta 700 016
Hindustan Computer Ltd., Reprographic Div., Skyline House, 85 Neheru Place, New Delhi 110 019.
Kilburn Reprogaphics Ltd., 2, Fairlie Place, Calcutta 700 001.
Kores India, Illaco House, Brabourne Road, Calcutta 700 001.
Modi Xerox Ltd., Modipur, Shahjadnagar, Rampur 244 901.

Richo Murphy Ltd., Tobacco House, 1/2, Old Court House Street, Calcutta 700 001.

Fire-fighting equipments

Amrex Engineering Enterprise, 4 Grace Building, Jalimnagar, Vandrup, Bombay 400 078
Apollo Fire Fighters, 16 Kala Industrial Estate, LBS Marg, Vandrup, Bombay 400 078.
Bharat Fire Engineers, 3/6 Anupam Industrial Estate, Mulund, Bombay 400 080.
Fire Control Service, 1/11/5 Khadak Street, Bombay 400 009.
Fire Equipment Co., 1/18, Caurria Industrial Estate, Jacob Circle, Bombay 400 011.
Fire Protection System, 7/3 Fire Star, Poona 1.
Firex Fire Engineering Works P. Ltd., 148 Mahatma Gandhi Road, Bombay 400 023.
Indian Fire Engineering Co., S. V. Road, Bombay 400 050.
Jinex Fire Services, 17 Arun Chambers, Tardeo Road, Bombay 400 034.
Minimax Fire Security Engineers, Steelage Industries Ltd., Opp. Mazagaon Post Office, Bombay 400 010.
Real Value Appliances, Bombay.

Steel Furnitures

Godrej & Boyce Mfg. Co. P. Ltd., Godrej Bhavan, Home Street, Bombay 400 001.
Steelage Industries Ltd., Opp. Mazagaon Post Office, Bombay 400 010.
Vinar System P. Ltd., 5/A, Lord Sinha Road, Calcutta 700 071.

Tissue Paper

Tissue paper is not available in the open market in India. Import license is necessary to import it from abroad. All import licensses are subject to approval from National Archives of India, New Delhi. In case of urgent requirement of small quantity of tissue paper, National Archives may consider supplying the same from their own stock. We are providing below names of some of the suppliers of the same.

Andrew Nelson, White Head, 31-1048th Avenue, Long Island City, New York 11101.

B. W. Elson Paper Co. Inc., 2501 Briton Hill Road, P. B. 11246, Richmound, Varginia-23230, U. S. A.

Barkan Green & Co. Ltd., Hoyle Mill, Maidstone, Kent ME 156XQ, England.

Folkner Fine Paper Ltd., 117, Acre, Connout Garden, London WC2E9PA, England.

James R. Crompton & Brothers Ltd., Elton Paper Mills, Lancashire, England.

Tairiku No Taiwasha Sha Ltd., Kioshige Building, 2-18-23 Takada, Toshima Ku, Tokyo 171, Japan.

Equipments for Spraying Insecticides etc.

Agro Suppliers Syndicate, 16 Ganesh Chandra Avenue, Calcutta 700 013.

Akbarally Associate, 5-1-42, Basirbag, Hyderdad 560 029.

East India Agro Distributors, 10 Clive Street, Calcutta 700 001.

Equipments for Lamination etc.

Arbee Co. Inc., 6 Claremount Road, Burndsville, New Jarcey 07924, U. S. A.

Astra Machino Impex, Zagreb, Yugoslovakia.

Eugo-Intra Co., 24B Theatre Road, Calcutta 700 071.

W. J. Barrow Restorasion Shop Inc., Richmound, Varginia 23219, U. S. A.

Chemicals and allied materials

Abhoy Ashram, College Street, Calcutta 700 012.

Agromore Ltd., Mysore Road, Bangalore 560 026.

Alkali & Chemical Corpn. of India Ltd., 34 Chowringhee, Calcutta 700 016.

Avery India Ltd., 12B Russell Street, Calcutta 700 071.

Aviyant (Plastic) P. Ltd., 4/1 Madan Street, Calcutta 700 013.

Banerjee Enterprise, 7/1 Sitaram Bose Lane, Salkia, Howrah 6.

Banamali Enterprise, 19A Jadu Bhattachryay Lane, Calcutta 700 026.

Bayer (India) Ltd., Express Towers, Nariman Point, Bombay 400 021.

Belami Fine Chemicals P. Ltd., 253 Gujarat Vepari Mahamandal Shakari Audyogik Vasahat, Ahmedabad 380 021.

Biosco (P) Ltd., 14 Hare Street, Calcutta 700 001.

Bombay Chemicals P. Ltd., 125 M. Gandhi Road, Bombay 400 023.

Britex Industries, 1/5 Banaji Street, Fort, Bombay 400 001.

Central Insecticides & Fertilisers, 110 Industrial Estate, Indore 452 003.

Chemical & Instruments Ltd., 55 Ezra Stteet, 2nd Floor, Calcutta 700 001.

Chemico Industries, 32 Ezra Street, 8th Floor, Room 959, Calcutta 700 001.

Chemper (P) Ltd., 24 Rabindra Sarani, Calcutta 700 073.

Commercial India, 56/1 Biplabi Rashbehari Basu Road, Calcutta 700 001.

Continental Trading Agency, 76 Diamond Harbour Road, Calcutta 700 023.

D. Jayantilal & Co., 33 Biplabi Rashbehari Basu Road, Calcutta 700 001.

Delstar P. Ltd., Ogalevedi, Satara District, Maharastra.

Devidayal (Sales) P. Ltd., Tulsiram Gupta Mills Estate, Reay Road, Bombay 400 010.

Durgapur Chemicals Ltd., 6 Russel Street, Calcutta 700 071.

G. P. Enterprise, 2B, Chandi Bose Lane, Calcutta 700 001.

Goodwill Chemical Industries, 495/97 Kalibari Road, Bombay 400 002.

India Alkalies Ltd., 5 Gastin Place, Calcutta 700 001.

Indofil Chemicals Ltd., Nirlon House, Dr. Annie Besant Road, Bombay 400 025.

International Chemical Industries, 89 Mahatma Gandhi Road, Calcutta 700 007.

Khadi Gramodyog Bhavan, Chittaranjan Avenue, Calcutta 700 013.

Laboratory Equipments and Chemicals, 11 Polock Street, 5th Floor, Calcutta 700 001.

Macrom Marketing, 5 Lenin Sarani, Calcutta 700 013.

Metcon Engineering Co., 67B Netaji Subhas Road, Room 14, First Floor, Calcutta 700 001.

Mukherjee & Co., 42 Lenin Sarani, Calcutta 700 013.

Mysore Insecticide Co. P. Ltd., 6 Linghi Chetty Street, Madras 600 001.

National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021.

Optronics Laboratory, Mango Lane, Calcutta 700 001.

P. Mitra & Sons., 4/1 Patoarbagan Lane, Calcutta 700 009.

Pesticides India, Udaisagar Road, Udaipur, Rajasthan.

Plastic Engineering, 227/1 Upper Circular Road, Calcutta 700 020.

R. D. Enterprise, 51/4 Nepal Bhattacharjee First Lane, Calcutta 700 026.

S. K. Agencies, 119A Chittaranjan Avenue, Calcutta 700 007.

S. K. Mukherjee & Co., 124A Rasbehari Avenue, Calcutta 700 029.

Scientific Instrument & Chemicals Co., 24 Camac Street, Calcutta 700 016.

Scientific Supply Agency, 29A College Street, First Floor, Calcutta 700 073.

Selective Chemicals P. Ltd., Ruvapari Road, Bhavnagar 364 001.

Superchem, 132 Dr. Annie Besant Road, Worli, Bombay 400 018.

Wason Brothers, 46 Chowringhee Road, Calcutta 700 087.

Pest Control Services

Dr. Swarup's P. Ltd., 216/2A Acharya Jagadish Bose Road, Calcutta 700 017.

Pest Control (I) P. Ltd., 23 Mirza Galib Street, Calcutta 700 016.

Pest Control Chemicals, 108A Elliot Road, Calcutta 700 016.

Pest Control Institute, 155 Park Street, Calcutta 700 017.

Pest Control Perfect, 86 Dr. Suresh Sarkar Road, Calcutta 700 014.

Pest Cotrol Services, 4D Ramtanu Bose Street, Calcutta 700 006.

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